Welcome to the October 18, 2017, Edition of THE REVENGE HUMP DAY!

I sure wished I could have gone to the last Con*Stellation in Huntsville, AL because from all reports it was a great sendoff for a great convention. I have been going for the past 34 years and this was the first time I ever missed one. Getting old is a bitch. But I was very fortunate in that I have had a ton of company this weekend and it was wonderful.

Michael and Sandy Ankenbrandt came by on Saturday night and we had a wonderful visit. Michael and Sandy are gun collectors and I even surprised him with an interesting article on YouTube. Kel Tek has produced a new bullpup rifle called a BDR that is unique. It appears to be small in length and it has the most interesting ejection mechanism. The problem with most rifles is that they can be set up for left hand firing or right hand firing because of the ejection mechanism of the spent shell. Well, this one ejects straight down from the bottom of the small buttstock and takes care of the problems with a the rifle. Also the rifle is very simple mmechanically and contains a full length barrel. This will be one rifle that some people will not like because of it's small size. I think Kel Tek has a winner here.

Rich and Tish Groller also went to Con*Stellation but are staying with SHE WHO MUST BE OBEYED and I while they are looking for some land down here in the Big Nooga Area. Yes, Rich and Tish have decided that they are going to move down here when they retire. It will be great to have them close.

Then last night we had another group of visitors who went to Con*Stellation. Jean Goddin and Mike Willmoth from Scottsdale, Arizona came a little out of their way to visit. We had a wonderful time just catching up and talking about old times. They had to get on their way home and couldn't stay the evening, but it was wonderful seeing them. I am blessed with friends who care.

So on that "happy note", why don't y'all sit back and relax because here's the best in gossip, jokes and science for your reading pleasure!

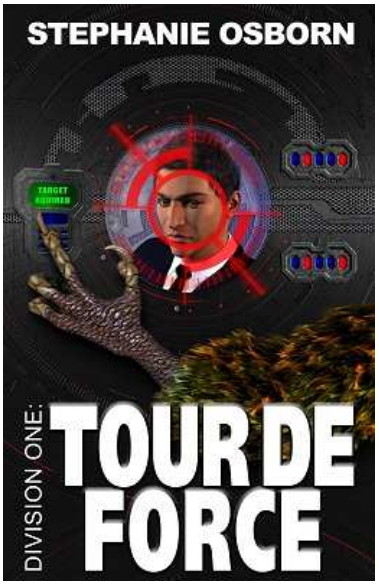
Uncle Timmy

<G>~<O>~<S>~<S>~<I>~<P>~~~<S>~<T>~<A>~<R>~<T>~<S>~~~<H>~<E>~<R>~<E>~<!>

Chromosphere Press Announces Division OneBook Four from Stephanie Osborn!

From: "Stephanie Osborn" steph@stephanie-osborn.com

10 OCTOBER 2017
FOR IMMEDIATE RELEASE
HUNTSVILLE, AL



Now available: Book 4 in the Division One series, Tour de Force!

Alpha One is participating in Omega's very first First Contact diplomatic operation. Unfortunately, it's going to split up the team—the Cortians, a race from the Sagittarius Dwarf Galaxy, have stringent requirements, and that narrows

down the list of "candidate exchange students" to...Echo. ONLY Echo. PGLEIA's top Division One Agent, the man being groomed to be the next Director...and Omega's partner. A plum assignment, for the pick of the crop.

But Omega doesn't see it that way, though she can't—or won't—explain why. She is determined to stop the mission from going forward. At any cost.

Why is Omega trying to scuttle a diplomatic mission? What is she seeing that more experienced Agents aren't? Why won't the others listen? Is something bigger, more menacing, happening to her—to them? Will—CAN—Alpha One survive?

Award-winning author Osborn is a 20+-year space program veteran, with multiple STEM degrees. She has authored, co-authored, or contributed to more than 30 books. In addition to the Division One series, she currently writes the critically-acclaimed Displaced Detective Series, described as "Sherlock Holmes meets The X-Files," and the Gentleman Aegis Series, whose first book was a Silver Falchion winner. She "pays it forward" through numerous media including radio, podcasting and public speaking, and working with SIGMA, the science-fiction think tank. Osborn's website is http://www.stephanie-osborn.com.
Division One series book four, Tour de Force, will be released in ebook formats on 10 October 2017, and in trade paperback format on 24 October. Additional installments in the ongoing series are anticipated next year.

ISBN:
978-0-9982888-9-5 (ebook)
978-1-947530-00-3 (print)

The ebooks are now available for order at:

Amazon: https://www.amazon.com/dp/B075BR4D8H/ref=sr_1_1?s=digital-text&ie=UTF8&qid=1504403571&sr=1-1

Barnes-Noble: https://www.barnesandnoble.com/w/division-one-stephanie-osborn/1127205214?ean=2940158738821

Other formats, and trade paper, will be available from your favorite bookseller! (Print release is slated for 24 October.)

Future books in the series are planned for 2018.

<L>~<I>~<B>~<E>~<R>~<T>~<Y>~<C>~<O>~<N>

RE: NFL

From: "Jerry Tollett" haleja@epbfi.com

I agree with you 100%!! Tonight James and I were at Amigo's and they had the channel on the football game.

Someone complained and asked they change the channel. I WAS LOVING IT!!!!!!!!!!

<L>~<l>~<B>~<E>~<R>~<T>~<Y>~<C>~<O>~<N>

Re: Gun Control

From: "Anita S. Moore" foofighterubu@gmail.com

Where many of its saddened by the events in Las Vegas. I'm also confused by the mindset that so blindly blames lack of gun control and our Second Amendment with criminal actions of people who will get the guns no matter what the gun control laws are. I'm sending you a picture to illustrate this fact. I know it doesn't make any sense it has been said again and again and again if you take away all the guns then only criminals criminals will have them.

<L>~<l>~<B>~<E>~<R>~<T>~<Y>~<C>~<O>~<N>

Re: The October 11, 2017, Edition of THE REVENGE HUMP DAY!

From: "Rich Zellich" rich@zellich.net

Pam Adams fails to remember history with her comment that the "act of terrorism...couldn't have been solved by 'a good guy with a gun,' unless that good guy was a sniper."

The infamous Texas Tower massacre was stopped by just such a person. A citizen with a rifle came to the aid of the pistol-armed police and fired at the sniper, keeping his head down and keeping him from picking off any more victims, so the police had a chance to get at him without being picked off themselves. The police thanked him profusely for his timely and effective help.

It appears that the Texas "open carry" protesters that everybody made fun of for carrying long guns in public actually had the right idea. Self defense does not always depend on the availability of a handgun, whether carried openly or concealed, but on the availability of a _suitable_ firearm. Col. Jeff Cooper understood this - while he practically single-handedly invented the modern combat pistol sports and many of the combat pistol techniques widely used today - said "a pistol is just so you can fight your way to a rifle."

Pam also says she thinks there are better ways to control firearms. We have the definitive law on that already, it says "the right of the people to keep and bear arms shall not be infringed."

Any method of "control" is an infringement on an inherent right - it is also 100% useless, because laws mean nothing to the lawless. Gun "control" laws are aimed solely at the responsible, law-abiding citizen, not the criminal or insane person, who will simply ignore them. That should tell us something about the real goals of those who would pass even more such laws - and we already have over 20,000 of those useless laws on the books, not one of which has ever prevented a crime (but citizens with guns have prevented many).

Cheers, Rich

<L>~<l>~<B>~<E>~<R>~<T>~<Y>~<C>~<O>~<N>

Re: The October 11, 2017, Edition of THE REVENGE HUMP DAY!

From: "Frank Brayman" afranklin3@gmail.com

Mad Minute with the Short Lee-Enfield Mark III*.

Mad Minute Part 1: https://www.youtube.com/watch?v=_IjG1SUh5ak
Mad Minute Part 2: https://www.youtube.com/watch?v=1DhjUrqH88s&t=14s

The guy's name is Rob, he's a Canadian from Alberta, and he's done a lot of demos like this with pre-1945 British Empire rifles. Note how he loads with magazine chargers in the vids. He's keeping thumb and index finger on the bolt handle and pulling the trigger with his bird finger, which speeds things up a little. I've done that too, but not during the demo I described in the post I sent for this week's Revenge.

If you're interested in more like this, his YouTube channel is British Muzzle Loaders:

https://www.youtube.com/channel/UCK-MdBJJw-0qlJZgw8dO1Ag

<T>~<H>~<E>~~~<J>~<O>~<K>~<E>~<S>~~~<S>~<T>~<A>~<R>~<T>~~~<H>~<E>~<R>~<E>

From: "Jerry Tollett" haleja@epbfi.com

Dear Son,

I'm writing this slow 'cause I know you can't read fast. We don't live where we did when you left. Your dad read in the paper that most accidents happen within twenty miles of home, so we moved. Won't be able to send you the address as the last Arkansas family that lived here took the numbers with them for their house, so they wouldn't have to change their address.

This place has a washing machine. The first day I put four shirts in it, pulled the chain and haven't seen 'em since.

It only rained twice this week, three days the first time and four days the second time.

The coat you wanted me to send to you, Aunt Sue said it would be a little too heavy to send in the mail with them heavy buttons, so we cut them off and put them in the pockets.

We got a bill from the funeral home, and it said if we didn't make the final payment on Grandma's funeral bill, up she comes.

About your sister, she had a baby this morning. I haven't found out whether if it is a boy or a girl so don't know if you are an Aunt or Uncle.

Your Uncle John fell in the whiskey vat. Some men tried to get him out, but he fought them off playfully, so he drowned. We cremated him and he burned for three days.

Three of your friends went off the bridge in a pickup. One was driving and the other two were in the back. The driver got out. He rolled down the window and swam to safety. The other 2 drowned. They couldn't get the tail gate down.

Not much more news this time. Nothing much happened. If you don't get this letter, please let me know and I will send another one.

Love, Ma

<J>~<O>~<K>~<E>~<S>

TWO NUNS VISITING THE USA.....

Two Irish nuns have just arrived in USA by boat, and one says to the other, "I hear that the people in this country actually eat dogs."

"Odd," her companion replies, "but if we shall live in America, we might as well do as the Americans do."

As they sit, they hear a push cart vendor yelling, "Hot Dogs, get your dogs here," and they both walk towards the hot dog cart.

"Two dogs, please!," says one. The vendor is very pleased to oblige, wraps both hot dogs in foil and hands them over. Excited, the nuns hurry to a bench and begin to unwrap their 'dogs.'

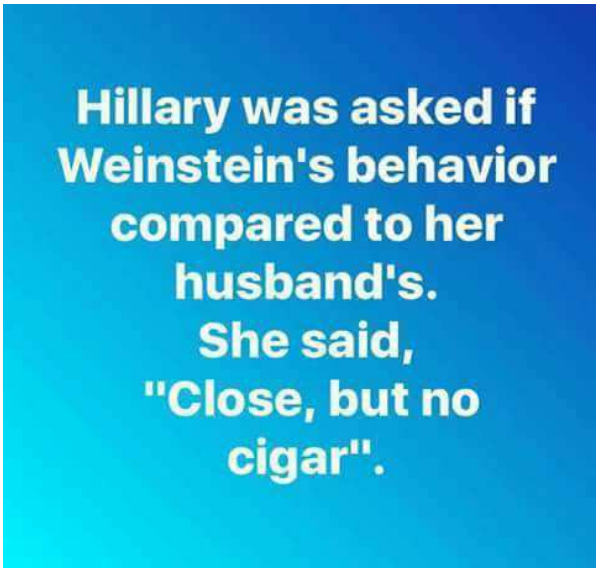
The mother superior is first to open hers. She begins to blush, and then, after staring at it for a moment, leans to the other nun and in a soft brogue whispers:

"What part did you get?"

<J>~<O>~<K>~<E>~<S>~~<of>~<the>~~<W>~<E>~<E>~<K>

Tacky Alert: The following is quite tacky, but very funny.

From: "Jim Woosley" jimwoosley@aol.com



<J>~<O>~<K>~<E>~<S>~~~<of>~<the>~~~<W>~<E>~<E>~<K>

From: "Mike Waldrip" waldripk@gmail.com

COMBAT TRUISMS
Never share a foxhole with ?anyone braver than you.
Never look important; the enemy may be low on ammo.
Never draw fire; it irritates everyone around you.
Never forget that your weapon is made by the lowest bidder.

OCS

Officer candidate school at Fort Sill, Oklahoma, was tough. During an inspection, a fellow soldier received 30 demerits for a single penny found within his area. Ten demerits were for "valuables insecure," ten because the penny wasn't shined, and ten because Abraham Lincoln needed a shave.

BOOT CAMP
My brother and I arrived at boot camp together. On the first morning, our unit was dragged out of bed by our drill sergeant and made to assemble outside. "My name's Sergeant Jackson," he snarled. "Is there anyone here who thinks he can whip me?"

My six-foot-three, 280-pound brother raised his hand and said, "Yes, sir, I do."
Our sergeant grabbed him by the arm and led him out in front of the group. "Men," he said, "this is my new assistant. Now, is there anyone here who thinks he can whip both of us?"

PARACHUTE PROBLEMS
The topic of the day at Army Airborne School was what you should do if your parachute malfunctions. We had just gotten to the part about reserve parachutes when another student raised his hand.
"If the main parachute malfunctions," he asked, "how long do we have to deploy the reserve?"

Looking the trooper square in the face, the instructor replied, "The rest of your life."

<J>~<O>~<K>~<E>~<S>

Basic Flying Rules

Try to stay in the middle of the air.

Do not go ?near the edges of it.

The edges of the air can be recognized by the ?appearance of ground, buildings, sea, trees, and interstellar space.

It is much more difficult to fly there.

<J>~<O>~<K>~<E>~<S>

THE TELEPHONE CALL

I was preparing lunch for my granddaughter when the phone rang. "If you can answer one question," a young man said, "you'll win ten free dance lessons."

Before I could tell him I was not interested, he continued. "You'll be a lucky winner if you can tell me what Alexander Graham Bell invented."

"I don't know," I replied dryly, trying to discourage him.

"What are you holding in your hand right now?" he asked excitedly.

"A bologna sandwich."

"Congratulations!" he shrieked. "And for having such a great sense of humor…"

<YOU>~<>~<JUST>~<>~<CAN'T>~<>~<MAKE>~<>~<THIS>~<>~<STUFF>~<>~<UP!>

YOU JUST CAN'T MAKE THIS STUFF UP!

From: "Tim Bolgeo" tbolgeo@epbfi.com

DELINGPOLE: MAN-MADE CLIMATE CATASTROPHE IS A MYTH, MORE STUDIES CONFIRM

by JAMES DELINGPOLE10 Oct 20171,755

http://www.breitbart.com/big-government/2017/10/10/delingpole-man-made-climate-catastrophe-is-a-myth-more-studies-confirm/

AP/Nam Y. Huh

From the world of science – as opposed to grant-troughing junk science – two more studies confirming that the man-made global warming scare is a myth.

One, a study by Scafetta et al, published in International Journal of Heat and Technology, confirms that the "Pause" in global warming is real – and that "climate change" is much more likely the result of natural, cyclical fluctuations than man-made CO2 emissions.

Abstract

The period from 2000 to 2016 shows a modest warming trend that the advocates of the anthropogenic global warming theory have labeled as the "pause" or "hiatus." These labels were chosen to indicate that the observed temperature standstill period results from an

unforced internal fluctuation of the climate (e.g. by heat uptake of the deep ocean) that the computer climate models are claimed to occasionally reproduce without contradicting the anthropogenic global warming theory (AGWT) paradigm. In part 1 of this work, it was shown that the statistical analysis rejects such labels with a 95% confidence because the standstill period has lasted more than the 15 year period limit provided by the AGWT advocates themselves. Anyhow, the strong warming peak observed in 2015-2016, the "hottest year on record," gave the impression that the temperature standstill stopped in 2014. Herein, the authors show that such a temperature peak is unrelated to anthropogenic forcing: it simply emerged from the natural fast fluctuations of the climate associated to the El Niño–Southern Oscillation (ENSO) phenomenon. By removing the ENSO signature, the authors show that the temperature trend from 2000 to 2016 clearly diverges from the general circulation model (GCM) simulations. Thus, the GCMs models used to support the AGWT are very likely flawed. By contrast, the semi-empirical climate models proposed in 2011 and 2013 by Scafetta, which are based on a specific set of natural climatic oscillations believed to be astronomically induced plus a significantly reduced anthropogenic contribution, agree far better with the latest observations.

Note also that it says the computer-modelled predictions of climate doom relied on by all global warming alarmists to support their thesis are wrong.

The second study, by Hodgkins et al, published in the Journal of Hydrology, concerns flooding in North America and Europe.

What it shows is that, contrary to the claims often made by climate alarmists, there has been NO increase in flooding due to "global warming" or "climate change."

Flooding events, it shows, have more to do with chance than any noticeable long term trend. It finds no link between flooding and "global warming."

Abstract

Concern over the potential impact of anthropogenic climate change on flooding has led to a proliferation of studies examining past flood trends. Many studies have analysed annual-maximum flow trends but few have quantified changes in major (25–100 year return period) floods, i.e. those that have the greatest societal impacts. Existing major-flood studies used a limited number of very large catchments affected to varying degrees by alterations such as reservoirs and urbanisation. In the current study, trends in major-flood occurrence from 1961 to 2010 and from 1931 to 2010 were assessed using a very large dataset (>1200 gauges) of diverse catchments from North America and Europe; only minimally altered catchments were used, to focus on climate-driven changes rather than changes due to catchment alterations. Trend testing of major floods was based on counting the number of exceedances of a given flood threshold within a group of gauges. Evidence for significant trends varied between groups of gauges that were defined by catchment size, location, climate, flood threshold and period of record, indicating that generalizations about flood trends across large domains or a diversity of catchment types are ungrounded. Overall, the number of significant trends in major-flood occurrence across North America and Europe was approximately the number expected due to chance alone. Changes over time in the occurrence of major floods were dominated by multidecadal variability rather than by long-term trends. There were more than three times as many significant relationships between major-flood occurrence and the Atlantic Multidecadal Oscillation than significant long-term trends.

A few take-home points from these studies.

One, they explode – yet again – the myth that there is a consensus among scientists about catastrophic man-made climate change. In fact, as I reported earlier this year, there are dozens of papers produced every year by reputable, honest scientists which call into question the great man-made climate change scare.

Two, the alarmists hate it when you point this out. After my Breitbart piece Global Warming is a Myth, Say 58 Scientific Papers in 2017, an alarmist website published a supposed expert rebuttal by leading climate scientists. The problem was, of course, that all the "experts" involved were members of the alarmist cabal who pal-review one another's papers and who ruthlessly shut out of the debate any scientists who dare to disagree with them.

Three, the alarmists know the jig is up and have done for some time. But in the interests of damage limitation they're trying to drip out their corrections (aka admissions of error) slowly – and on their terms – rather than allow any hated skeptics (like yours truly) the chance to crow.
This is what happened after that bombshell paper released in Nature Geoscience last month by leading climate alarmists including Oxford University's Myles Allen. Buried beneath its misleading and dull abstract was an extraordinary admission: that their computer models had wildly overestimated the effects of carbon dioxide on global warming.

Which in turn means, of course, that the entire AGW scare (which relies above all else on those computer models) is bunk and that really – "Big Mac meal with Coke, 5 chicken select, curry dip and two large teas, thanks Myles" – it's about time these taxpayer-funded Chicken Littles did something useful with their lives for a change.

But when journalists pointed this out, the alarmists responded by attacking the journalists, supposedly for having misrepresented their paper. Yeah right. Look guys, if a dodgy company – say Enron Inc – releases its annual report with a summary that says: "Good news. Our profits are up again and our prospects are better than ever" but on closer examination of the company accounts this turns out to be drivel, it is not the job of journalists to report that rosy executive summary, however much Enron/Global Warming Inc might prefer it.

Let's get something absolutely clear about this global warming debate. (I may have mentioned this before but it's worth restating). Anyone at this late stage who is still on the alarmist side of the argument is either a liar, a cheat, a crook, a scamster, an incompetent, a dullard, a time-server, a charlatan or someone so monumentally stupid that they really should be banned by law from having an opinion on any subject whatsoever.

And that's just the scientists.

The parasitic industry profiting from all that junk-science nonsense the alarmists keep pumping into the ether is even worse.

Just one brief example. The other week, the British press was chock full of stories about this incredible advance which had been made in the offshore wind turbine industry

whereby costs had fallen so markedly that suddenly those sea-based bat-chomping, bird-slicing, whale-killing eco-crucifixes were more competitive than ever before. There was barely a newspaper that didn't fall for this "good news" propaganda story.

The story had been heavily promoted by a number of vested interests: a "coalition of companies and civil society organisations" (including Dong Energy, GE, ScottishPower Renewables, Siemens Gamesa, SSE, Vattenfall, Greenpeace, Marine Conservation Society, and WWF."
Look at that list and marvel and the range and influence and financial muscle of those co-conspirators. Mighty, global NGOs and vast industrial conglomerates with a combined income running into the many billions. Environmentalism is not some gentle, bunny-hugging Mom and Pop operation. It's a ginormous, many tentacled, spectacularly greedy and corrupt Green Blob.

And guess what? That story – repeated unquestioningly by the MSM, crowed about by the BBC – was horse shit. Actually, it was worse than that: it was fox shit, which – as anyone who has smelt it will know – is an altogether more noisome, pungent, vile substance.

Now the Global Warming Policy Foundation has reported these liars to the Advertising Standards Authority.

And Paul Homewood has done the numbers and worked out that actually, far from being a bargain, this is yet another massive taxpayer rip off.

Never forget this next time you hear anyone bleating about Trump doing something sensible like pulling out of the Paris climate accord or scrapping the Clean Power Plan. The global warming scare is the biggest scam in the history of the world. It cannot be killed off soon enough.

<S>~<C>~<I>~<E>~<N>~<C>~<E>~~~<S>~<T>~<A>~<R>~<T>~<S>~~~<H>~<E>~<R>~<E>

From: "Tim Bolgeo" tbolgeo@epbfi.com

HOW USING MOLTEN SALT TO COOL NUCLEAR REACTORS IS GAINING MOMENTUM IN THE SOUTHEAST

Knoxville News-Sentinell,October 10, 2017
http://www.energycentral.com/news/how-using-molten-salt-cool-nuclear-reactors-gaining-momentum-southeast?utm_medium=eNL&utm_campaign=DAILY_NEWS&utm_content=93924&utm_source=2017_10_11

Oct. 10--Molten salt reactors, a scientific innovation previously passed over by the Department of Energy, are gaining momentum as the next "big thing" in clean energy production.

The Oak Ridge National Laboratory hosted a mix of researchers, regulators, venture capitalists and reactor developers at its third annual molten salt reactor workshop last week. There, vendors talked about design, fuel, safety and regulations that pertain to the pursuit of advanced reactor technology.

As far as advanced reactors go, molten-salt cooled reactors are nothing new to ORNL. The laboratory constructed the first experimental molten salt reactor in 1964. It reached nuclear criticality the next year.

The Department of Energy was looking into nuclear energy at the time, the laboratory built and studied 13 different kinds of reactors. The Energy Department ended up moving forward with reactors cooled by light water, which are widely used today.

So, the Oak Ridge National Laboratory decommissioned the experimental molten salt reactor just five years after it reached criticality.

"The molten salt reactor experiment was very successful in that it demonstrated that concept worked and successfully," said Alan Icenhour, associate director of the Nuclear Science and Engineering Directorate.

"As we move to the future, there's rekindled interest in what's called advanced reactor technology, and that's looking into how we can further improve and extract even more energy from that," he said.

The reactors work by pumping molten salt in a loop to cool off hot uranium fuel in a continuous reaction. The reactors are appealing because they operate at very low pressure and at high temperatures, which makes them more energy efficient than existing water-cooled reactors.

"They've become attractive not only in the United States, but in other countries as people investigate it and see that the characteristics of these reactors lend themselves to being beneficial as a power source," Icenhour said.

Nuclear reactors have lifespans, and reactors in the southeast are expected to start going offline in the 2030s. By the 2050s, none of the existing nuclear reactors in the southeast will be operational.

Many reactor developers at the conference hope to begin implementing molten salt reactors into the grid by the mid-2020s.

"We would like this technology to be ready to fill that void if it can be and if it makes sense," said Lou Qualls, ORNL's national technical director for molten salt reactors. "So we're studying it now to see if it's a technology that we could have ready in time."

Still, Qualls said, there are cynics of the technology.

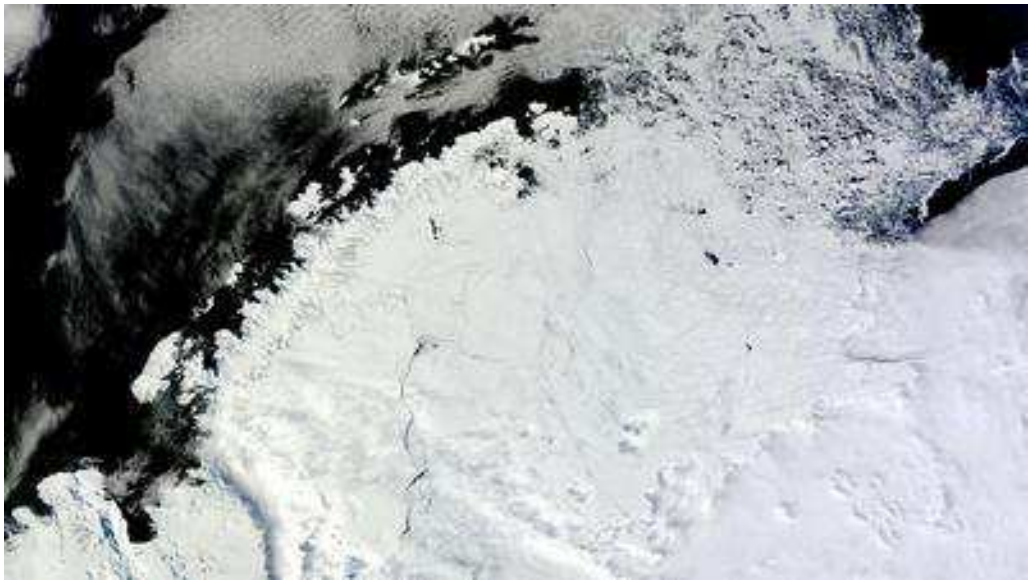
**"The real competition for the market is the status quo," Qualls said.
"What we're doing today isn't going to be what's going to work in the future, so we have to innovate and improve. When you just kind of explain to people that it's been done before we did this 50 years ago and it worked pretty well, that's the first thing they're surprised about. We've done this and it worked."**

<S><C><I><E><N><C><E>

A GIANT, MYSTERIOUS HOLE HAS OPENED UP IN ANTARCTICA

"We're still trying to figure out what's going on."

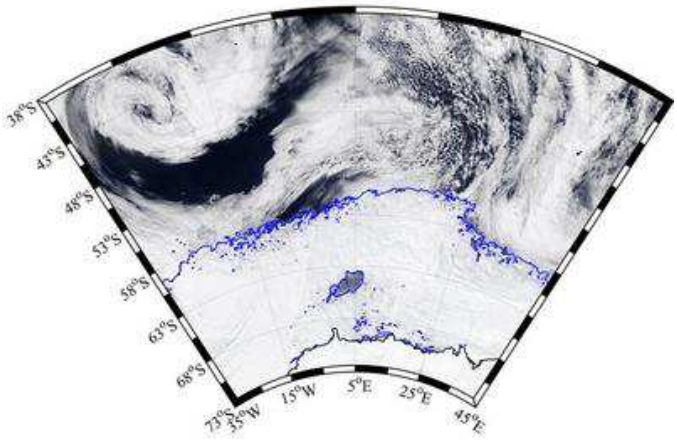
Kate Lunau Oct 10 2017, 12:55pm
https://motherboard.vice.com/en_us/article/wjx9w4/a-giant-mysterious-hole-has-opened-up-in-antarctica



Antarctica's Weddell Sea. Image: Jeff Schmaltz/LANCE/ EOSDIS Rapid Response/Jesse Allen/NASA

A hole as large as Lake Superior or the state of Maine has opened up in Antarctica, and scientists aren't sure why it's there.

The gigantic, mysterious hole "is quite remarkable," atmospheric physicist Kent Moore, a professor at the University of Toronto's Mississauga campus, told me over the phone. "It looks like you just punched a hole in the ice."



An image of the hole in the sea ice. Image: MODIS-Aqua via NASA Worldview; sea ice contours from AMSR2 ASI via University of Bremen

Areas of open water surrounded by sea ice, such as this one, are known as polynias. They form in coastal regions of Antarctica, Moore told me. What's strange here, though, is that this polynia is "deep in the ice pack," he said, and must have formed through other processes that aren't understood.

"This is hundreds of kilometres from the

ice edge. If we didn't have a satellite, we wouldn't know it was there." (It measured 80,000 k? at its peak.)

A polynia was observed in the same location, in Antarctica's Weddell Sea, in the 1970s, according to Moore, who's been working with the Southern Ocean Carbon and Climate Observations and Modelling (SOCCOM) group, based at Princeton University, to analyze what's going on. Back then, scientists' observation tools weren't nearly as good, so that hole remained largely unstudied. Then it went away for four decades, until last year, when it reopened for a few weeks. Now it's back again.

"This is now the second year in a row it's opened after 40 years of not being there," Moore said. (It opened around September 9.) "We're still trying to figure out what's going on."

It's tempting to blame this strange hole on climate change, which is reshaping so much of the world, including Antarctica. But Moore said that's "premature." Scientists can say with certainty, though, that the polynia will have a wider impact on the oceans.

"Once the sea ice melts back, you have this huge temperature contrast between the ocean and the atmosphere," Moore explained. "It can start driving convection." Denser, colder water sinks to the bottom of the ocean, while warmer water comes to the surface, "which can keep the polynia open once it starts," he said.

Using observations from satellites and deep sea robots, Moore and his collaborators are working on as-yet-unpublished research that aims to answer some of these questions. "Compared to 40 years ago, the amount of data we have is amazing," he said.

Antarctica is undergoing massive changes right now, and figuring out why a gaping hole could suddenly open up will be key to understanding larger systems at play.

Get six of our favorite Motherboard stories every day by signing up for our

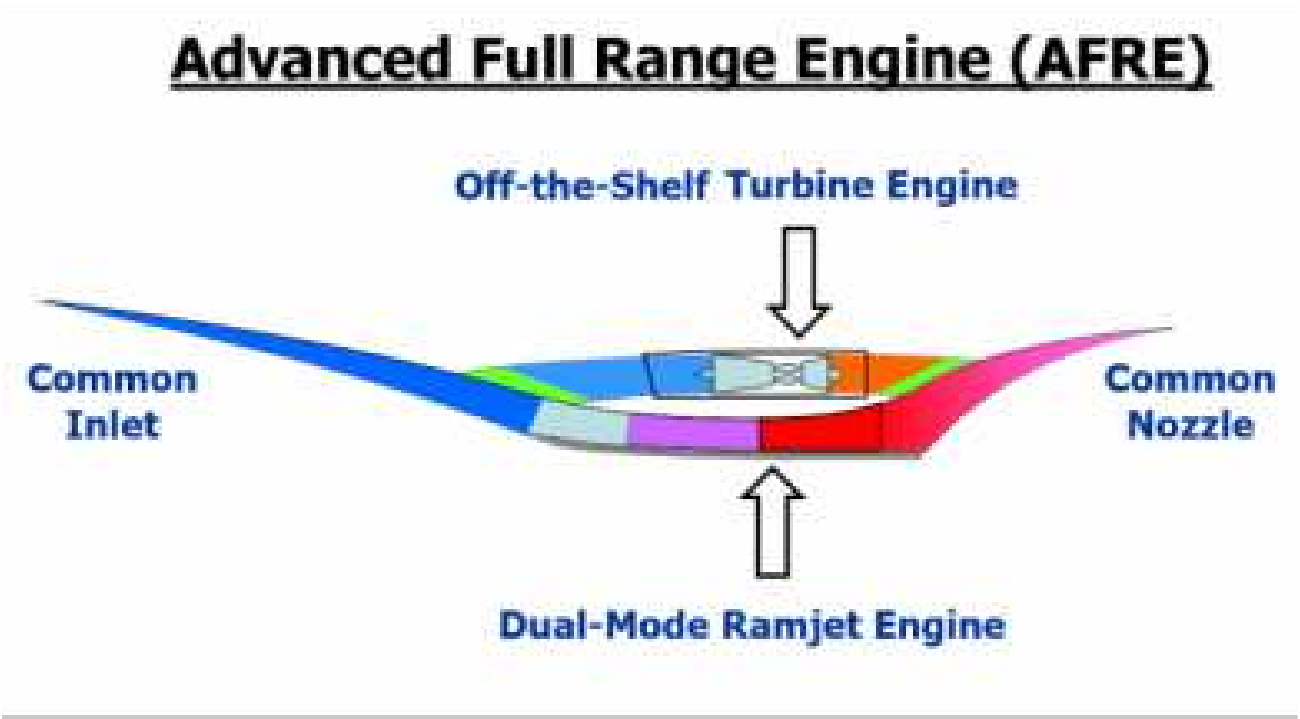
<S><C><I><E><N><C><E>

AEROJET ROCKETDYNE TO DEMO COMBINED-CYCLE HYPERSONIC ENGINE

Oct 9, 2017Graham Warwick | Aerospace Daily & Defense Report
http://aviationweek.com/defense/aerojet-rocketdyne-demo-combined-cycle-hypersonic-engine?NL=AW-05&Issue=AW-05_20171012_AW-05_330&sfvc4enews=42&cl=article_8_4&utm_rid=CPEN1000003019593&utm_campaign=12052&utm_medium=email&elq2=d11bb15787d64cc0b5fb8d07327985c9

As the U.S. steps up research and development for hypersonic weapons, DARPA has awarded Aerojet Rocketdyne a contract to demonstrate a turbine-based combined cycle (TBCC) engine that could power a reusable high-speed aircraft from takeoff to beyond Mach 5.

The award comes amid reports that Lockheed Martin's Skunk Works is making progress toward flying an F-22-sized, TBCC-powered flight research vehicle by 2020 as a precursor to the larger SR-72 high-speed aircraft proposed for the late 2020s.



AFRE concept: DARPA

DARPA's Advanced Full Range Engine (AFRE) program differs from previous hypersonic TBCC development efforts in that it combines an off-the-shelf turbine engine with a dual-mode ramjet/scramjet (DMRJ).

Previous programs required an unproven high-Mach turbojet in an attempt to bridge the gap between the highest speed at which a turbine engine can operate and the lowest speed at which a ramjet can take over. Conventional turbojets can operate up to around Mach 2.5, but ramjets cannot operate effectively much below Mach 3.5.

AFRE revisits ground DARPA wanted to cover in the Mode Transition (MoTr) program launched in 2009, but which was terminated before ground tests planned for 2012. MoTr was intended to demonstrate TBCC mode transition from turbojet to ramjet to scramjet, from zero airspeed to Mach 6 and back. The program was to use a turbojet capable of reaching Mach 3-4 before transitioning to the DMRJ.

"Through the AFRE program, we aim to mature the design and component technologies and bring them together to conduct a full system-level turbine-based combined cycle ground test demonstration," Aerojet Rocketdyne CEO and President Eileen Drake says.

The technical challenge of AFRE involves extending the operability of the conventional turbine engine up to higher Mach number and the operability of the DMRJ down to lower Mach number to enable mode transition. The engines will share a common inlet and nozzle, with the turbine "cocooned" at high speed and then restarted once the hypersonic vehicle slows down for return to a runway landing.

DARPA documents show AFRE was planned to be based on an available Rolls-RoyceF405 Adour small turbofan, possibly fitted with a special afterburner enabling operation to higher

Mach number. Aerojet Rocketdyne has previously developed the SXJ61 hydrocarbon-fueled and -cooled scramjet that in 2013 powered the Boeing X-51A WaveRider demonstrator to a speed exceeding Mach 5.1.

Other technical challenges include thermal management in all propulsion phases; integrated propulsion and transition control; matching mass flows through the different flowpaths; achieving combustion stability in the DMRJ; restarting the turbine engine at high speeds and dynamic pressures; and the ability to scale the TBCC design up to power full-size hypersonic vehicles.

Under the program, large-scale components of the propulsion system will first be demonstrated independently, followed by a full-scale freejet ground test of the TBCC mode transition. Accomplishing these objectives will enable future air-breathing hypersonic systems for long-range strike, high-speed intelligence, surveillance and reconnaissance, and two-stage-to-orbit space access, DARPA says.

Conceptual design of a hypersonic vehicle was completed in fiscal 2017 to enable definition of the ground demonstration engine performance requirements. Plans for fiscal 2018 include beginning testing of a large-scale common inlet and full-scale DMRJ combustor, completing fabrication of the full-scale common nozzle and beginning integration of the off-the-shelf turbine engine.

<S><C><I><E><N><C><E>

SPIKE AEROSPACE UNMANNED SX-1.2 DEMONSTRATOR MAKES MAIDEN FLIGHT

David Szondy, October 10th, 2017
http://newatlas.com/spike-aerospace-sx-12-maiden-flight/51674/

Spike Aerospace took to the skies for the first time on Saturday as it tested a subsonic, subscale version of its planned S-512 supersonic passenger plane. The unmanned SX-1.2 prototype demonstrator took off from a private airfield in New England with KrishnaKumar Malu and Mike Ridlon piloting it remotely on the first of a series of seven short flights throughout the day, to prove the validity of the aircraft's aerodynamics.

Saturday's flight took place under what the company called perfect weather with winds of 7 to 10 mph (11 to 16 km/h) and the temperature hovering around 70º F (21º C). During the tests, telemetry of the flight characteristics and other performance data were recorded and aircraft's center of mass, balance, and control surfaces were adjusted between flights.

"These test flights are providing incredibly valuable information which we can use to refine the design," says Malu. "I am very excited about how helpful these tests will be to our supersonic development program."

The data from the tests will be used to modify the design of the full sized S-512. This will be a 22-passenger supersonic jet with a range of 6,200 mi (9,977 km) that's designed to fly over standard airliner routes at Mach 1.6 (1,218 mph, 1,960 km/h) thanks to its low-boom signature fuselage using a modified delta wing design. In addition, it will be one of the first jets to replace traditional windows with video walls providing a stem-to-stern view of the exterior.

The test flight was of an unmanned demonstrator aircraft – not the version pictured here(Credit: Spike Aerospace)

The S-512 is being developed with the assistance of Siemens, Quartus, Aernnova, Greenpoint, BRPH, and others with a projected flight date of 2021 and first deliveries in 2023. Currently, Spike is making modifications to the SX-1.2 for more test flights in November, followed by construction of the successor SX-1.3 demonstrator.

"The SX-1.2 test flights were conducted in a real world situation, and provide significantly more data than wind tunnel tests done in an artificial environment," says Vik Kachoria, President and CEO of Spike Aerospace. "We were able to test not only handling, but also a range of other considerations."

Source: Spike Aerospace

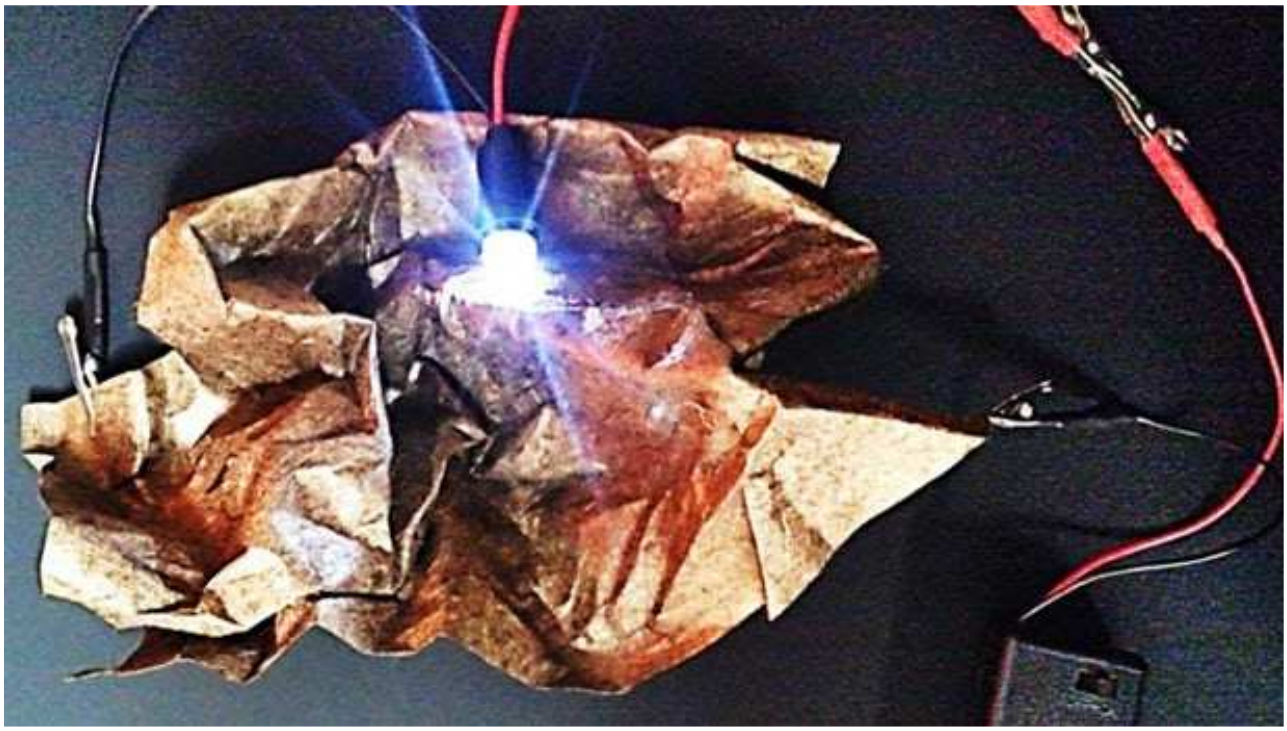
<S><C><I><E><N><C><E>

METALLIZED PAPER MAKES FOR FLEXIBLE, FOLDABLE SUPERCAPACITORS

Michael Irving, October 11th, 2017
http://newatlas.com/flexible-paper-supercapacitor/51702/

If batteries are the marathon runners of the energy storage world, then supercapacitors are sprinters: great for short bursts of power but not so great long-term. Now engineers from Georgia Tech and Korea University have developed a new supercapacitor that's designed to store more energy for longer – and it's made out of ordinary paper, meaning it's flexible enough to power wearable electronics.

Batteries have high energy density but low power density, meaning they're great at storing energy for long periods of time but they can only release power in a relative trickle. Supercapacitors meanwhile have the opposite problem: they can blast out far more power at once, but their reservoirs can never be quite as full in the first place. For their new design, the researchers wanted to develop a supercapacitor with the right balance between energy density and power density.



The new supercapacitor, made from metallized paper, can be folded up without losing its conductivity(Credit: Ko et al., Nature Communications)

To this end, the team developed a relatively easy process to make just such a device. First, a piece of paper is dipped into a solution that contains an amine surfactant material, before it's then dipped into a solution full of gold nanoparticles. The surfactant helps the gold enter the fibers in the paper and stick there.

Next, the scientists use the same method to add layers of metal oxide materials, including manganese oxide. In the end, the gold layers conduct electricity and the metal oxide layers store it, making for a superconductor that not only has high energy and power densities, but can be folded and scrunched without losing those abilities.

"It's basically a very simple process," says Seung Woo Lee, co-author of the study. "The layer-by-layer process, which we did in alternating beakers, provides a good conformal coating on the cellulose fibers. We can fold the resulting metallized paper and otherwise flex it without damage to the conductivity. We have nanoscale control over the coating applied to the paper. If we increase the number of layers, the performance continues to increase. And it's all based on ordinary paper."

The metallic-paper supercapacitor has a power density of 15.1 mW/cm2 and an energy density of 267.3 uW/cm2, which the researchers say makes it the highest-performing textile supercapacitor yet developed. The technique to make it can be scaled up and possibly sprayed onto larger sheets of paper.

"There should be no limitation on the size of the samples that we could produce," says Lee. "We just need to establish the optimal layer thickness that provides good conductivity while minimizing the use of the nanoparticles to optimize the tradeoff between cost and performance."

Next up, the team plans to try using fabric as the base material, and eventually develop batteries using the same process. The gold nanoparticles also have to go, since they're too expensive for wider use, so the researchers plan to experiment with copper or silver nanoparticles to produce the same effect.

"This type of flexible energy storage device could provide unique opportunities for connectivity among wearable and internet of things devices," says Lee. "We could support an evolution of the most advanced portable electronics. We also have an opportunity to combine this supercapacitor with energy-harvesting devices that could power biomedical sensors, consumer and military electronics, and similar applications."

The research was published in the journal Nature Communications.

Source: Georgia Tech

<S><C><I><E><N><C><E>

CHERNOBYL'S WILD ANIMALS BRING RADIOACTIVITY TO SWEDEN

Wild Boar Found With 10 Times Safe Radiation

October 12, 2017, Written by L Todd Wood

https://tsarizm.com/news/2017/10/12/chernobyls-wild-animals-bring-radioactivity-sweden/

Wild animals from the Chernobyl region are migrating to Northern Europe and bringing their radiation with them. Wild boar have recently been killed in Sweden with ten times the safe radiation level.

"Hunters won't shoot the animals," Calluna environmental consultant Ulf Frykman told Fox News.

Frykman explained that, of 30 wild boar samples taken from the area surrounding the city of Gävle this year, only six were below the safe radiation limit of 1,500 becquerel per kilogram (Bq/kg). Alarmingly, flesh from one wild boar that had been killed by hunters registered a massive 16,000 Bq/kg, while others were 13,000 and 11,000 Bq/kg.

"When you see 16,000 [Bq/kg], people get worried," he said, reported New York Post. He is worried in coming years the problem could be much worse with 20 or 30 times safe radiation levels found in wildlife.

Frykman stated that wild boar are particularly susceptible to radiation, "The cesium stays in the ground," he said. "It's not a problem for moose and deer any more who eat higher up, from bushes."

"The families of wild boars are growing fast – it's worrying," he said, wrote the New York Post.

Reports of irradiated dogs and other wildlife have surfaced recently as the delayed effects of one of the worst nuclear disasters make their presence known decades later in the region.

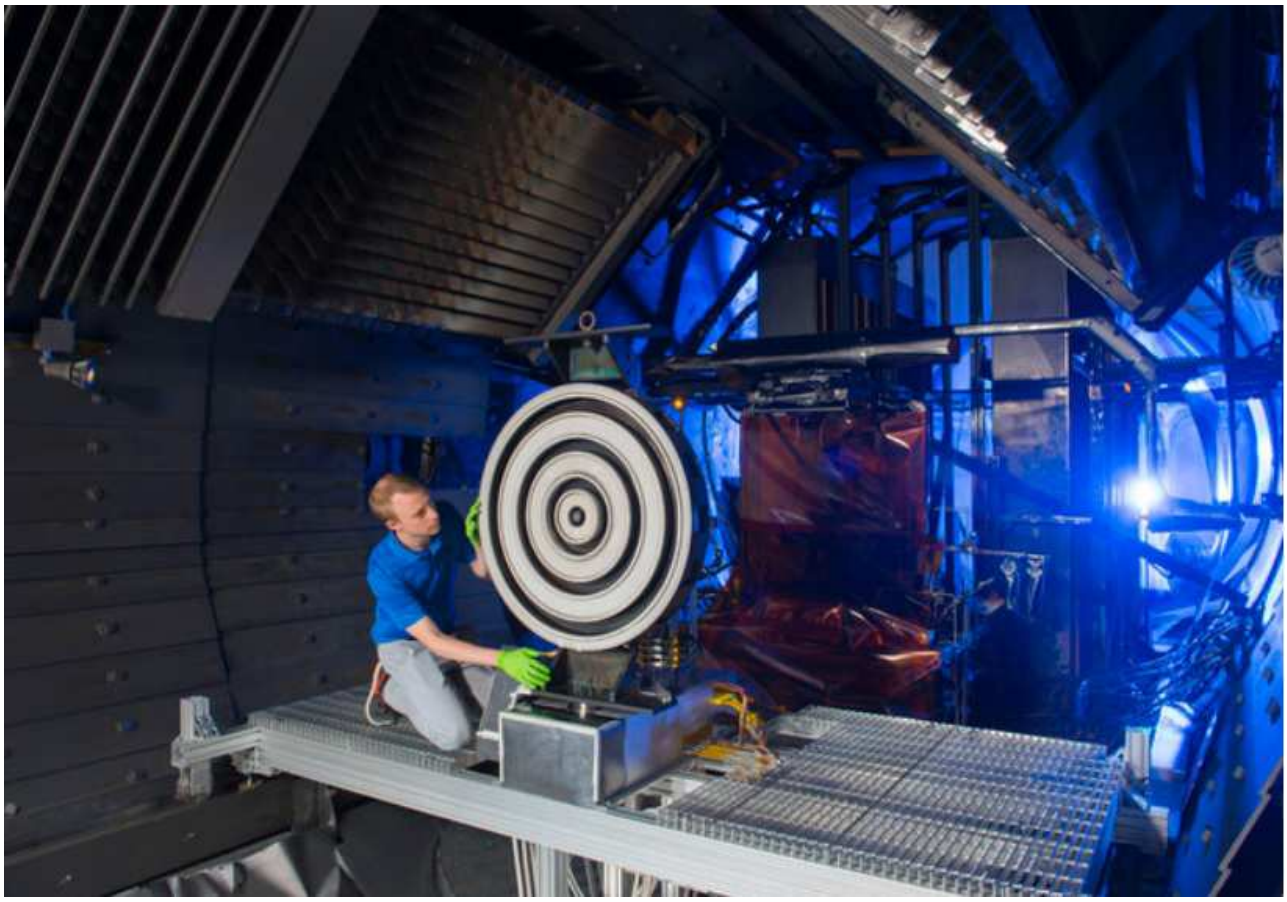
Similar issues have been reported in Fukushima as well.

<S><C><I><E><N><C><E>

ION THRUSTER PROTOTYPE BREAKS RECORDS IN TESTS, COULD SEND HUMANS TO MARS

By Tereza Pultarova, Space.com Contributor | October 13, 2017 07:00am ET
https://www.space.com/38444-mars-thruster-design-breaks-records.html

A thruster that's being developed for a future NASA mission to Mars broke several records during recent tests, suggesting that the technology is on track to take humans to the Red Planet within the next 20 years, project team members said.



Scott Hall makes some final adjustments to the X3 ion thruster at the University of Michigan before a test. Credit: NASA

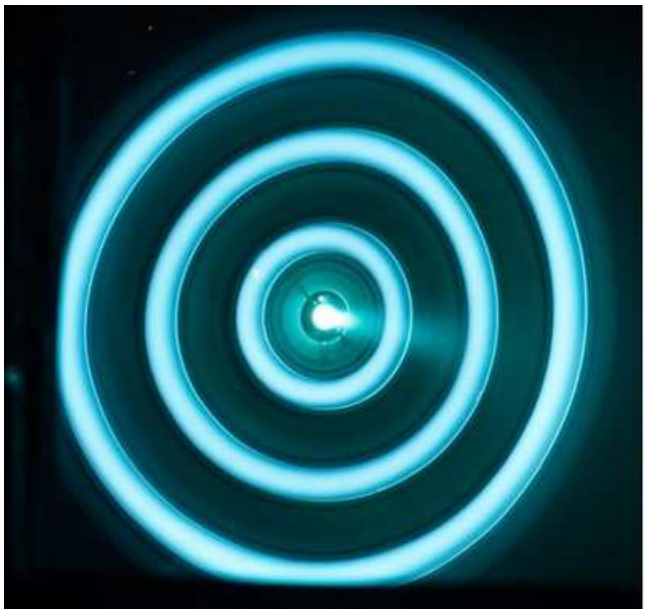
The X3 thruster, which was designed by researchers at the University of Michigan in cooperation with NASA and the U.S. Air Force, is a Hall thruster — a system that propels spacecraft by accelerating a stream of electrically charged atoms, known as ions. In the recent demonstration conducted at NASA's Glenn Research Center in Ohio, the X3 broke records for the maximum power output, thrust and operating current achieved by a Hall thruster to date, according to the research team at the University of Michigan and representatives from NASA.

"We have shown that X3 can operate at over 100 kW of power," said Alec Gallimore, who is leading the project, in an interview with Space.com. "It operated at a huge range of power from 5 kW to 102 kW, with electrical current of up to 260 amperes. It generated 5.4 Newtons of thrust, which is the highest level of thrust achieved by any plasma thruster to date," added Gallimore, who is dean of engineering at the University of Michigan. The previous record was 3.3 Newtons, according to the school.

Hall thrusters and other types of ion engines use electricity (usually generated by solar panels) to expel plasma — a gas-like cloud of charged particles — out a nozzle, thus generating thrust. This technique can propel spacecraft to much greater speeds than chemical propulsion rockets can, according to NASA.

That's why researchers are so interested in ion propulsion's potential application for long-distance space travel. Whereas the maximum velocity that can be achieved by a chemical rocket is about 5 kilometers per second, a Hall thruster could get a craft up to 40 kilometers per second, Gallimore said.

Ion engines are also known to be more efficient than chemical-powered rockets, featuring what Gallimore described as a better "miles per gallon" ratio. A Hall-thruster-powered spacecraft would get cargo and astronauts to Mars using much less propellant than a chemical rocket, he said. (A common propellant for ion thrusters is xenon; indeed, NASA's Dawn spacecraft, which is currently orbiting the dwarf planet Ceres, uses this gas.)



A head-on shot of the X3 ion thruster firing at 50 kilowatts, viewed through a warped mirror in the vacuum chamber. Credit: NASA

"You can think of electric propulsion as having 10 times the miles per gallon compared to chemical propulsion," Gallimore told Space.com.

The trade-off with ion thrusters, however, is that they are very low thrust and therefore must operate for a long time to accelerate a spacecraft to high speeds, according to NASA. (In addition, ion thrusters aren't powerful enough to overcome Earth's gravitational pull, so they cannot be used to launch spacecraft.)

"Chemical propulsion systems can generate millions of kilowatts of power, while the existing electrical systems only achieve 3 to 4 kilowatts," Gallimore said.

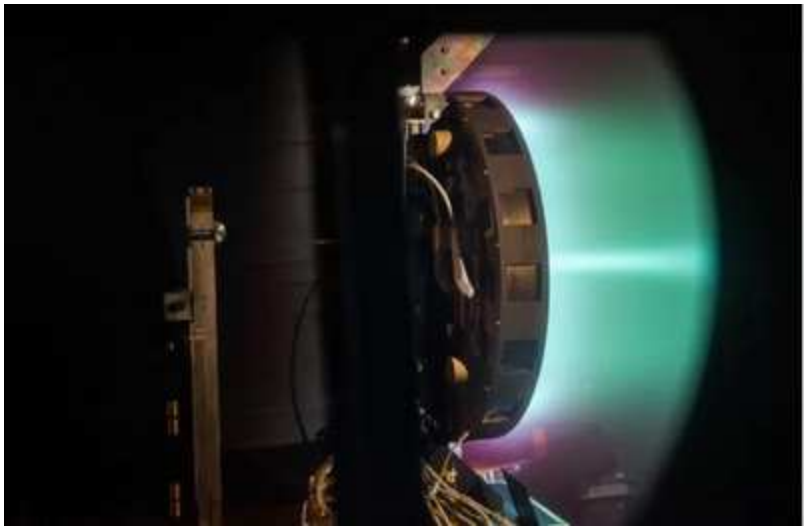
Commercially available Hall thrusters are not nearly powerful enough to propel a crewed Mars spacecraft, he added.

"What we would need for human exploration is a system that can process something like 500,000 watts (500 kW), or even a million watts or more," Gallimore said. "That's something like 20, 30 or even 40 times the power of conventional electric propulsion systems."

That's where the X3 comes in. Gallimore and his team are addressing the power problem by making the thruster bigger than these other systems and by developing a design that addresses one of the technology's shortcomings.

"We figured out that instead of having one channel of plasma, where the plasma generated is exhausted from the thruster and produces thrust, we would have multiple channels in the same thruster," Gallimore said. "We call it a nested channel."

According to Gallimore, using three channels allowed the engineers to make X3 much smaller and more compact than an equivalent single channel Hall thruster would have to be.



A side shot of the X3 ion thruster firing at 50 kilowatts. Credit: NASA

The University of Michigan team has been working on the technology in cooperation with the Air Force since 2009. First, the researchers developed a two-channel thruster, the X2, before moving on to the more powerful X3, which has three channels.

In February 2016, the team partnered with California-based rocket-maker Aerojet Rocketdyne, which is developing a new electrical propulsion system, called XR-100, for NASA's Next Space Technologies for Exploration Partnerships, or NextSTEP program. The X3 thruster is a central part of the XR-100 system.

Scott Hall, a Ph.D. student at the University of Michigan who has worked on the X3 project for the past five years, said the work has been rather challenging because of the thruster's size.

"It's heavy — 500 pounds [227 kilograms]. It's almost a meter in diameter," Hall said. "Most Hall thrusters are the kind of thing that one or two people can pick up and carry around the lab. We need a crane to move X3 around."

Next year, the team will run an even bigger test, which aims to prove that the thruster can operate at full power for 100 hours. Gallimore said the engineers are also designing a special magnetic shielding system that would keep the plasma away from the walls of the thruster to prevent damage and enable the thruster to operate reliably for even longer periods of time. Gallimore said that without the shielding a flight version X3 would probably start experiencing problems after several thousand hours of operations. A magnetically-shielded version could run for several years at full power, according to Gallimore.

<S><C><I><E><N><C><E>

TOSHIBA'S NEW FAST-CHARGING BATTERY COULD TRIPLE THE RANGE OF ELECTRIC VEHICLES

Nick Lavars, October 9th, 2017
https://newatlas.com/toshiba-scib-battery-triple-range/51667/

A key focus of electric vehicle (EV) makers is maximizing the range users can get from each charge, and for that reason new battery technologies are poised to play a huge part in driving their adoption. Toshiba has developed a new fast-charging battery it claims could

allow EVs to travel three times as far as they do now, and then be fully recharged again in a matter of minutes.

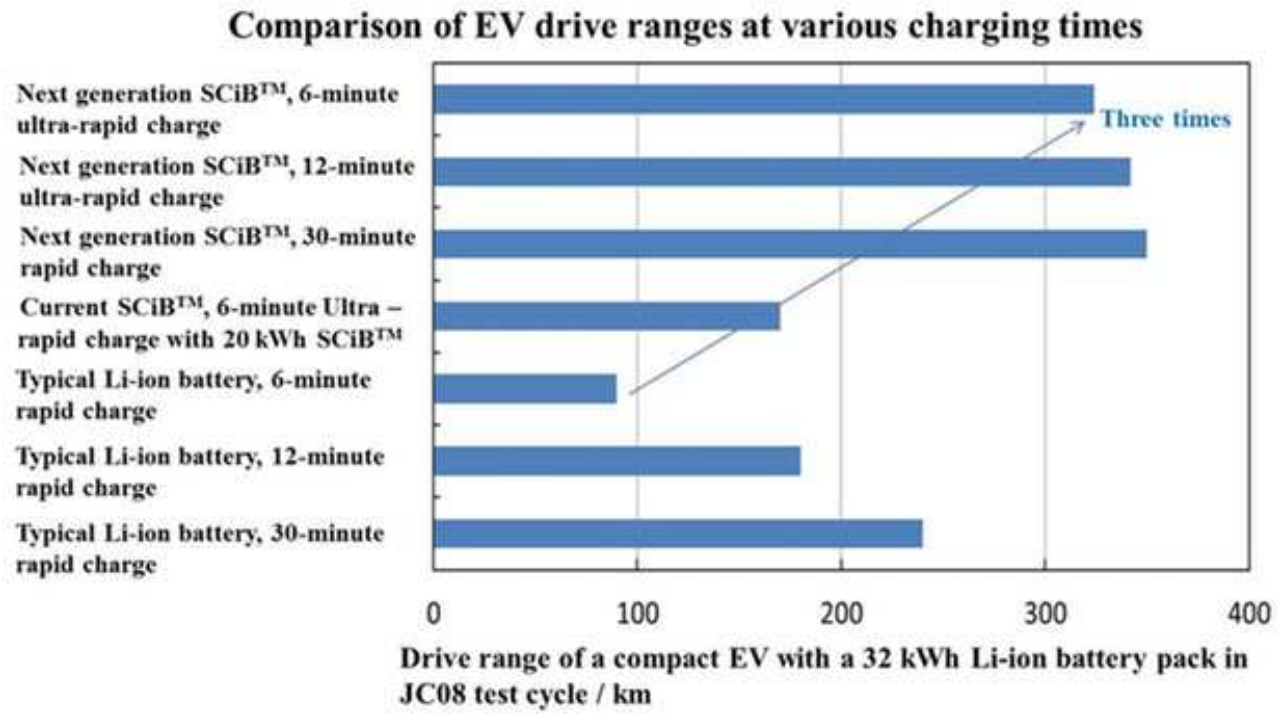
Toshiba has tested out a 50-Ah version of its new SCiB battery

Toshiba's SCiB (Super Charge ion Battery) has been around in various formssince 2007, with its chief claim to fame an ability to charge to 90 percent of capacity in just five minutes. It also boasts a life-span of 10 years and high levels of safety, and has found its way into a number of notable EVs, including Mitsubishi's i MiEV and Honda's Fit EV.

The current SCiB uses lithium titanium oxide as its anode, but Toshiba says it has now come up with a better way of doing things. The next-generation SCiB uses a new material for the anode called titanium niobium oxide, which Toshiba was able to arrange into a crystal structure that can store lithium ions more efficiently. So much so, that the energy density has been doubled.

Toshiba has tested out a 50-Ah version of the new battery and reckon that it too boasts excellent safety and a long life cycle, retaining more than 90 percent of its capacity after 5,000 charge cycles. It says that if incorporated into a compact EV, it would allow for a range of 320 km (186 mi) after just a six minutes of ultra-rapid charging, which is around three times the range offered by a standard, similarly charged lithium-ion battery.

"We are very excited by the potential of the new titanium niobium oxide anode and the next-generation SCiBTM," says Dr. Osamu Hori, Director of Corporate Research & Development Center at Toshiba Corporation. "Rather than an incremental improvement, this is a game changing advance that will make a significant difference to the range and performance of EV. We will continue to improve the battery's performance and aim to put the next-generation SCiBTM into practical application in fiscal year 2019."



Source: Toshiba

<S><C><I><E><N><C><E>

CHINESE SPACE STATION SET TO CRASH-LAND ON EARTH'S SURFACE WITHIN MONTHS

*** Launched in 2011, the 8.5-ton Tiangong-1 space laboratory had originally been a symbol of Beijing's ambitious scientific bid to become a space superpower.**

*** However, last year Chinese officials confirmed the country's first orbiting space station had to be scrapped after its functions failed following two years in space.**

*** China's equivalent of NASA, the China National Space Administration (CNSA), has informed the United Nations that the space station had begun its descent and would be carefully monitoring its final plunge.**

Sam Meredith, Published 8:49 AM ET Fri, 13 Oct 2017
https://www.cnbc.com/2017/10/13/tiangong-1-chinese-space-station-to-crash-land-on-earth-within-months.html

A Chinese space station has begun its out-of-control descent towards Earth's surface and is expected to crash-land within a few months.

Launched in 2011, the 8.5-ton Tiangong-1 space laboratory had originally been a symbol of Beijing's ambitious scientific bid to become a space superpower.

Chinese space station set to crash-land on Earth's surface within months 11:04 AM ET Fri, 13 Oct 2017 | 00:40

Chinese space station set to crash-land on Earth's surface within months 11:04 AM ET Fri, 13 Oct 2017 | 00:40

However, last year Chinese officials confirmed the country's first orbiting space station had to be scrapped after its functions failed following two years in space.

Since then, the space station known as "Heavenly Palace" has been gradually decaying and, in recent weeks, has accelerated its descent into the Earth's atmosphere.

PIECES WEIGHING AS MUCH AS 100KG MAY FALL FROM THE SKIES

Jonathan McDowell, an astrophysicist from Harvard University, told The Guardian in an interview published Friday that he anticipated Tiangong-1 to hit Earth's surface sometime between this month and April.

While much of the craft is expected to burn up in Earth's atmosphere, McDowell also reportedly said that some parts weighing as much as 100 kilograms could crash-land to Earth with scientists unable to predict where they will come down until only hours beforehand.

China's equivalent of NASA, the China National Space Administration (CNSA), has informed the United Nations that the space station had begun its descent and would be carefully monitoring its final plunge.

The chance that anyone would be harmed by Tiangong-1's debris is considered highly unlikely.

<S><C><I><E><N><C><E>

NOW BOARDING: THE TOP 10 PRIVATE SPACESHIPS

By Jesse Emspak, Space.com Contributor | October 16, 2016 06:40am ET

https://www.space.com/15735-top-private-spaceships-countdown.html

<S><C><I><E><N><C><E>

RS-25 ENGINES READY FOR MAIDEN FLIGHT OF NASA'S SPACE LAUNCH SYSTEM

by Staff Writers, Stennis Space Center MS (SPX) Oct 16, 2017
http://www.spacedaily.com/reports/RS_25_Engines_Ready_for_Maiden_Flight_of_NASAs_Space_Launch_System_999.html

Aerojet Rocketdyne displays the four RS-25 engines slated to fly on EM-1, the maiden flight of NASA's SLS rocket, at its facility located at NASA's Stennis Space Center. Image courtesy Aerojet Rocketdyne, Inc.

Aerojet Rocketdyne reports that four RS-25 engines slated to fly on Exploration Mission-1 (EM-1), the maiden flight of NASA's Space Launch System (SLS), are ready for integration with the rocket's core stage. EM-1 is a three-week mission in which the SLS rocket will launch the Orion spacecraft into a distant retrograde orbit around the moon farther than a human-rated vehicle has traveled before, and also will deliver 13 small satellites to deep space.

"The Space Launch System epitomizes our nation's legacy of ingenuity and our spirit of exploration," said Aerojet Rocketdyne CEO and President Eileen Drake. "When it launches, SLS will eclipse the performance of any rocket flying today or currently under development."

All four of the RS-25 engines that will fly during EM-1 also flew during the Space Shuttle Program; however, they have been outfitted with new controllers and adapted for SLS. Each engine provides half a million pounds of thrust, totaling more than 2 million pounds of thrust, for the first stage of the SLS rocket. An infographic about the first four engines and their flight history can be found here.

"These four EM-1 engines have a rich and storied history," said Dan Adamski, RS-25 program director at Aerojet Rocketdyne. "Together, they've powered 21 shuttle flights with the most experienced engine, E2045, having flown on 12 separate flights."

Aerojet Rocketdyne will store the four engines for EM-1 at its facility located at NASA's Stennis Space Center until they are ready for integration with the core stage, which is currently in development at NASA's Michoud Assembly Facility in New Orleans.

In addition to the core stage propulsion for the debut SLS flight, Aerojet Rocketdyne is also providing an RL10B-2 engine for the rocket's upper stage, which is called the Interim Cryogenic Propulsion Stage (ICPS).

The RL10B-2 produces 24,750 pounds of thrust and is the main propulsion once the rocket has reached outer space; it gives the Orion spacecraft the final boost to complete its mission around the Moon. Earlier this year, NASA delivered the completed ICPS to Cape Canaveral Air Force Station, Florida, in preparation for integration with the rocket.

"The propulsion for SLS is just one example of how all the pieces for Exploration Mission-1 are starting to come together. It is remarkable that our nation will soon debut this new capability that will enable humans to explore deep space," added Drake.

<S><C><I><E><N><C><E>~<N><E><W><S>

From: "Chris Cowan" cowanc1028@earthlink.net

Tap a keyboard in her honor....(And of course, there's the graphic novel "The Thrilling Adventures of Lovelace and Babbage")

And the Microcenter in Rockville has posters of computer persons on it's right-hand as yuou come in wall. RADM Grace Hopper is in the center - and for some unknown reason, hers is the only obviously-formerly-rolled-up poster.

ADA LOVELACE DAY HONORS "THE FIRST COMPUTER PROGRAMMER"

Scientists celebrate a 19th-century visionary—and the achievements of all women in science, engineering and math

By Yasemin Saplakoglu on October 10, 2017
https://blogs.scientificamerican.com/observations/ada-lovelace-day-honors-the-first-computer-programmer/

Ada Lovelace, circa 1840. Credit: Hulton Archive Getty Images

Someone encountering an "Analytical Engine" today would probably think it was part of a mechanical system for some bizarre car—or perhaps an obscure telegraph machine or some kind of eccentric musical instrument. We probably would not recognize this jumble of pins and cogwheels as the world's first computer. Although a working model was never completed, English mathematician Charles Babbage's design, first described in 1837, was extraordinary. And it had parallels with the modern computer, such as its "mill"—what we would now call a central processing unit.

At the time there was one curious and imaginative mind that recognized the strange machine's potential as a concept. In 1843 self-made mathematician Ada Lovelace

published a paper that detailed how the Analytical Engine worked, and contemplated the kind of far-reaching tasks she imagined it could perform. She is, via her annotations on the calculating machine, widely thought to have made a large contribution to the field of computer science and now stands as an inspiring symbol for women scientists. In 2009 Suw Charman-Anderson, former executive director of the London-based nonprofit Open Rights Group, designated the second Tuesday in October (a date chosen arbitrarily) as Ada Lovelace Day to celebrate women's achievements in math, science and engineering.

Lovelace lived a short but consequential life. Born in 1815 to a well-known aristocratic family, she was initially famous for being the daughter of English poet Lord Byron—who called Lovelace's mother, Annabella Byron, the "Princess of Parallelograms" for her love for mathematics. Their marriage was short, and Lord Byron disappeared from both their lives when Lovelace was an infant. Annabella, terrified Ada might develop her father's head-in-the-clouds romanticism, forbade her daughter from reading Lord Byron's poetry, and instead surrounded the child with math.

It worked. She grew up with her head in a book, studying and questioning algebra and geometry, and showing a growing fascination with machinery. At 17 she and her mother attended an event where Lovelace first encountered Babbage. He was demonstrating the prototype for his "Difference Engine," a simpler precursor to the Analytical Engine. The prototype was designed to calculate values based on a formula, reducing the manual labor required to create tables. The idea stoked Lovelace's fascination with machinery, and she set out to understand everything about the Difference Engine. As she grew into adulthood, she had several mentors including mathematician Augustus De Morgan, who tutored her in 1840 and 1841 through an exchange of 63 letters. De Morgan was patient and kind, answering questions that had puzzled Lovelace, filling in the gaps in her mathematical knowledge. In a letter to Annabella he noted the young mathematician's remarkable "power of thinking," saying it was "utterly out of the common way for any beginner, man or woman."

These exchanges provided material for a paper published in August 2017 in Historia Mathematica, presenting evidence for Lovelace's mathematical prowess and countering some historians' claims that her story may have been overhyped, and that she could not have had enough mathematical knowledge to have written the notes in her paper about the Analytical Engine—the feat for which she is best known.

In 1843 Ada translated a French paper written about Babbage's machine—including her annotations, which were almost twice as long as the paper itself. These included a thorough description of the workings of the machine, including how paper punch cards could be used to adjust the machine's settings. Lovelace also lingered on the possibility of using the device to compose music. And the notes went on to show how such a calculator might be able to compute a series of numbers that frequently pop up in higher arithmetic, called Bernoulli numbers—a process some might call the world's first computer program. Her insights floored Babbage. In a letter to his friend and English scientist Michael Faraday he called her "that Enchantress who has thrown her magical spell around the most abstract of Sciences and has grasped it with a force which few masculine intellects (in our country at least) could have exerted over it."

Adrian Rice, a mathematics professor at Randolph–Macon College in Virginia, and his colleagues at the University of Oxford spent long hours at the Bodleian Library in Oxford this past year, poring over and reordering the letters between Lovelace and De Morgan.

They drew several conclusions about her mathematical strengths such as her tendency to make perceptive observations about concepts and her predictions about ideas that would turn out to be true. The researchers say that by the end of her correspondence with De Morgan she had reached a university-level understanding of mathematics, and that her teacher was already introducing her to open-ended abstract questions. "A lot of people base this opinion [that Ada's accomplishments have been overblown] by saying that there's no way she could have written this because she didn't know enough math," Rice says. "Well what we show in our papers [is] yes, she did have enough math—she could definitely have done it." Rice adds he would consider her to be the world's first "debugger" more than the world's first computer programmer: For example, she found a large error that Babbage had made in his calculations, mirroring her attitude of questioning and finding mistakes in mathematical queries throughout her correspondence with De Morgan.

Lovelace died at just 36, but the science community has kept her legacy alive. In 1862, 10 years after her death, Scientific American published an excerpt from the Times of London that described an exhibition of machines, one of which was probably a half-built Analytical Engine. It read: "This is Mr. Babbage's great calculating machine, which will work quadrations and calculate logarithms up to seven places of figures. It was the account of this invention written by the late Lady Lovelace—Lord Byron's daughter—that led to Messrs. Scheutz, of Stockholm, to improve upon it to such an extent as not only enabled the machine to calculate its tables, but to print its results."

Lovelace has gradually become a pioneering symbol for all women who are in or aspiring to join the crazy whirlwind of science. And the second Tuesday of every October becomes a recognition not only of her but of all the women throughout history whose contributions have been forgotten or overlooked—or never been found.

The views expressed are those of the author(s) and are not necessarily those of Scientific American.

<S><C><I><E><N><C><E>

NEW TELESCOPE "GIVES BACK THE SKY" TO CITY-DWELLERS

By Lee Billings on October 10, 2017
https://blogs.scientificamerican.com/observations/new-telescope-gives-back-the-sky-to-city-dwellers/?WT.mc_id=send-to-friend

The Whirlpool Galaxy as seen through the eyepiece of Unistellar's eVscope from the Observatoire des Baronnies Provençales in France. Credit: Unistellar

Any astronomy buff will tell you about the first time they looked through a telescope. What many of them won't say, though, is how disappointing those first looks can be. I remember my own all too well, from when I was a boy. It was a glimpse from my suburban front yard of the majestic stellar nursery we call the Orion Nebula, hard-

won after close to an hour of setting up, pointing and focusing a modest refractor telescope my father had purchased at a department store. Through the eyepiece, the nebula didn't look at all like the crisp, colorful images I had seen in books and magazines. Instead, it was a gray smudge, easily mistaken for a wisp of cirrus cloud, its faint light washed out against the blue glare of a nearby mercury–vapor streetlamp. After that, the telescope just gathered dust—and with it, most of my desire to delve deeper into amateur astronomy.

At least that was the case until last month, when I tried a new sort of telescope at a stargazing party in a secluded spot of the sprawling Evergreens Cemetery in Brooklyn. Set up alongside several standard consumer models, the SETI Institute astronomer Franck Marchis is offering demonstrations of a prototype "Enhanced Vision Telescope" produced by the small French start-up Unistellar, where he also works as Chief Scientific Officer. Marchis is best known as the discoverer of multiple asteroids, and for coaxing remarkable observations from modest ground-based telescopes. He was the first to capture images of volcanic eruptions on Jupiter's moon, Io, without the aid of space telescopes or interplanetary probes, and is part of a vanguard of astronomers developing new technologies for imaging planets orbiting other stars. This night, however, he is merely serving as a celestial evangelist.

"What happened to you is what happens to almost everybody when they use a telescope to look at anything besides the moon and some of the planets," Marchis says when I tell him about my childhood experience. "You invest hundreds of dollars, you maybe drive far to get away from city lights, and you spend hours trying to align and calibrate your telescope to observe a galaxy or a nebula. You might think you'll see something like a pretty picture from the Hubble [Space Telescope]. But what you get is a blurry dot to show your kids or your wife or your partner, and they're disappointed. And then they're done!"
ADVERTISEMENT
Marchis traces his own interest in astronomy to a late night of boyhood bonding with his father in the French countryside, watching without a telescope as the Earth's shadow tinted the full moon red during a lunar eclipse. It was "the first moment in my life where I felt things were really happening in the sky," he says, "where I realized we are on this small rock we call Earth orbiting a star, and that there must be countless other worlds around all the other stars out there." Not long after, Marchis would be stargazing more seriously, staring at the rings of Saturn through his first telescope.

Called the "eVscope" (pronounced Ee-Vee Scope) for short, Unistellar's product outwardly appears to be just a typical 4.5-inch Newtonian reflector—a simple small telescope that, along with its tripod, easily fits inside a backpack. But a peek through its eyepiece reveals the eVscope's power: Using a proprietary system of sensors, optics and specialized software, the telescope can amplify and display the accumulated light from a faint target over time, stacking up and processing hundreds of images to correct for instrumental jitter and smeared exposures to build up vivid, sharp views that rival those from far larger and more expensive equipment. And, as Marchis intends to show with his demonstration from a Brooklyn graveyard, the technology even works under poor viewing conditions—such as in and around New York City, where the glare of city lights is so oppressive that even on clear nights one can practically count on fingers and toes all the stars visible to the naked eye. (The technology works so well, in fact, that Unistellar's eVscope has managed to capture and display images of faraway Pluto in its eyepiece as a dim and distant dot hanging in the light-polluted skies over Marseilles, France, and San Francisco.)

"Remember, this telescope isn't just about pretty pictures," Marchis says. "It could also lead to new ways of doing science." According to Marchis, by the time the eVscope hits stores it should be capable of imaging objects as faint as about 15 apparent magnitude—that is, as faint in Earth's skies as a 100-watt lightbulb seen from 30,000 kilometers away. That would, among other things, allow it to image, track and study tens of thousands of known asteroids, and to discover new ones as well. Through a partnership with the SETI Institute, eVscope users will have the option of automatically uploading their observations to an online database for use by amateur and professional astronomers alike. "We'll build it up slowly, with a thousand eVscopes providing millions of frames for any given region of sky that can be combined to get good signal to noise," Marchis says. "We could use it to search for Earth-threatening asteroids and comets, stellar occultations, supernovae, variable stars; maybe even things we can scarcely imagine—a flash of light, a laser pulse from another cosmic civilization? Who knows what we might find—it's not like we have been observing the sky continuously at these magnitudes."

To aid the acquisition and construction of that database, Unistellar is developing a semiautonomous "Field Recognition System" for the eVscope that uses GPS data to help point the telescope and identify objects of interest. That system, though, is not yet fully integrated into the prototype; during the demonstration Marchis guides the eVscope by hand, navigating with the help of an app on his smartphone.

Before being cut short by encroaching clouds, his demo reaches its zenith with a view of the Ring Nebula, a one-light-year–wide shell of gas cast off from a dying star about 2,000 light-years from Earth. After zooming in on the nebula's celestial coordinates, Marchis toggles the telescope's enhanced light-amplification mode, and steps back to let me look through the eyepiece. Within seconds, the nebula materializes from a glittering field of background stars like a polished disk of turquoise and coral nestled in black, diamond-studded velvet. The colors come from ionized nitrogen, hydrogen, oxygen and other gases that had once been in the dying star's atmosphere—and probably in some accompanying planets, too—now stripped away and set aglow by intense ultraviolet light from the star's slowly cooling white-hot core. A bit more than five billion years from now, astronomers guess, our sun and solar system will experience a similar fate. One by one, the other stargazers line up to peer at the stellar memento mori. A few even take out their smartphones to snap pictures of the nebula through the eyepiece.

Steps away, another telescope more than twice as large as Unistellar's is also trained on the Ring Nebula. Through its excellent but old-fashioned optics, the nebula appears as a vaguely doughnut-shaped gray mist against a background of pale stars. Like many faint sky objects, here it is best seen indirectly, slipping into invisibility when focused on and only appearing again out of the corner of the eye, as its trickles of photons fall on the retina's more light-sensitive edges rather than its more color-sensitive center. The difference is striking, and illustrative of why galaxies and other deep-sky objects can be so problematic to appreciate through ordinary telescopes. The nebula's vivid hues are there waiting to be seen, hidden due to the inherent limitations of the human eye. Paired with digital camera, a motorized star tracker and a laptop running imaging-processing software, any telescope could deliver a serviceable colorful image of the Ring Nebula in a matter of minutes—but not in a real-time glance through an eyepiece.

"There is no magic in what we are doing," Marchis says later, noting that high-powered amateur astronomers at past Unistellar events have replicated many of the eVscope's feats, albeit with much more (and far pricier) equipment and greater effort. "We are taking the

technology that professional astronomers have been using for years, and integrating it into a small, affordable telescope that anyone can use. The eVscope is meant to be equivalent to a smartphone, but for astronomy."

The company, Marchis says, hopes to bring the eVscope to market in fall 2018, at a price point similar to the latest iPhone or a mid-tier laptop. But, of course, he and others at Unistellar say they aren't making enhanced-vision telescopes for the money. Rather, they are trying to restore something they feel people—particularly those in bustling, starlight-starved cities—are at risk of losing: A connection with the heavens above.

"As an astronomer, I'm biased, of course, but it does matter, being able to see the stars," Marchis says after his demonstration ends. "When people lose that, they forget where they really are. They forget that they live on a tiny planet around a little star in a huge galaxy, and that we as human beings are more than a bunch of apes who want to buy fancy new cars or the latest Apple phone. We are part of a bigger picture. It's a big moment in your life, when you see and feel that for the first time. Exploring the entire universe can start with something tiny, like looking through a telescope. That's what happened to me when I saw my first eclipse with my father. Maybe we can make it happen for today's kids, too. For everyone. We want to give back the sky."

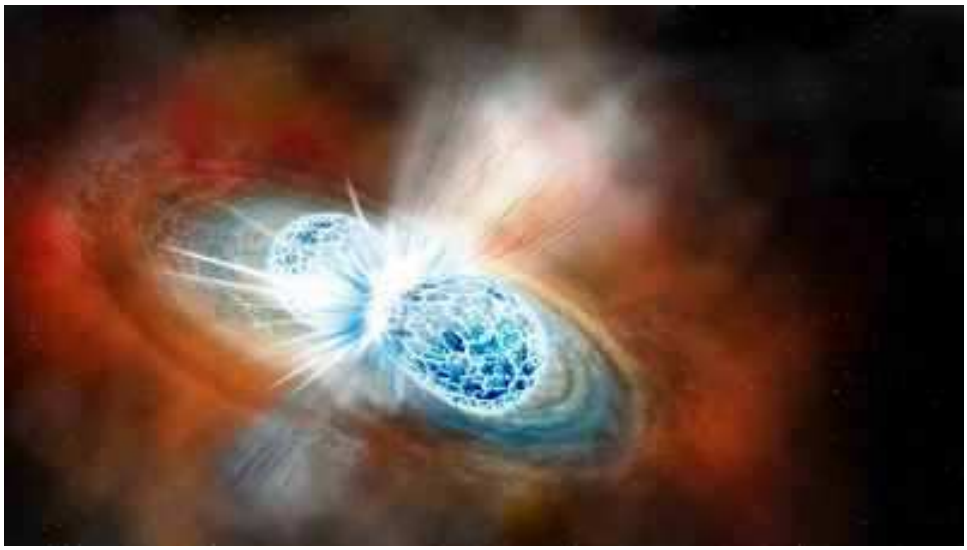
<S><C><I><E><N><C><E>

I don't know what the blank box at the end was - and it won't delete.

« GRAVITATIONAL WAVE HUNTERS SET TO MAKE BIG ANNOUNCEMENT MONDAY

Dawn of an Era: Astronomers Hear and See Cosmic Collision

By Eric Betz | October 16, 2017 9:00 am
http://blogs.discovermagazine.com/d-brief/2017/10/16/gravitational-wave-neutron-stars/?utm_source=SilverpopMailing&utm_medium=email&utm_campaign=News0_DSC_171016_000000_Final&utm_content=&spMailingID=31037036&spUserID=MTE2MDc4Njc2NTgxS0&spJobID=1142063036&spReportId=MTE0MjA2MzAzNgS2#.WeTLQMYpD1I



Two neutron stars merge into a kilonova. (Credit: Illustration by Robin Dienel, courtesy of the Carnegie Institution for Science)

For hundreds of millions of years, two city-sized stars in a galaxy not-so-far away circled each other in a fatal dance. Their dimensions were diminutive, but

each outweighed our sun.

They were neutron stars — the collapsed cores left behind after giant stars explode into supernovas. Closer and closer they spun, shedding gravitational energy, until the stars traveled at nearly the speed of light, completing an orbit 100 times every second.

By then, dinosaurs reigned on Earth, and the first flowers were just blooming. That's when, 130 million years ago, the dance ended.

The collision was fast and violent, likely spawning a black hole. A shudder — a gravitational wave — was sent out across the fabric of space-time. And as the stars' outer layers launched into space, the force formed a vast cloud of subatomic particles that would cool into many Earths' worth of gold, platinum and uranium.

Seconds later, a blast of high-energy gamma-rays – the most energetic kind of light – punched through the erupting cloud.

The space-time ripple and the light crossed the cosmos together, and finally arrived at 6:41 a.m. Eastern on Aug. 17. The gravitational wave first reached Italy's freshly finished detector Advanced Virgo before stretching and squeezing the lasers at America's two LIGO sites.

Two seconds later, NASA's gamma-ray detecting Fermi spacecraft caught the blast.

In the weeks since, hundreds of astronomers on all seven continents have turned their telescopes and spacecraft to watch the cosmic collision play out in all manner of light – radio, infrared, optical, ultraviolet, X-rays, gamma-rays. The Spitzer and Hubble space telescopes are still watching the event, as is the Very Large Array in New Mexico. Right now, it's the greatest show in astronomy.

"What was surprising with this one was it was extremely close to us, and so it was an extremely strong signal," says LIGO scientist Jolien Creighton of the University of Wisconsin-Milwaukee. "We were figuring with our full Advanced LIGO sensitivity we might see something like this every few years."

Ground-based observatories all over Earth, some 70 in all, as well as a handful of orbiting space telescopes, caught the neutron star merger. (Credit: LIGO and Virgo collaboration)
In February 2016, LIGO announced they'd detected gravitational waves for the first time, almost exactly a century after Albert Einstein predicted these events as an outcome of his theory of general relativity. Astronomers said that initial detection was like hearing the cosmos for the first time. And they hoped for the next breakthrough — to hear and see the cosmos simultaneously, or so-called "multi-messenger astronomy."

That's now happened.

The Multi-Messenger Age

"This is the first real multi-messenger astronomy," says astronomer Josh Simon of the Carnegie Observatories. "There are things you can discover with gravitational waves that

you could never see with electromagnetic light, and vice versa. Having that combination should provide us with insights into these extreme objects."

And this neutron star mash-up uncorked a jug of scientific firsts. A press briefing Monday morning outlined some of the dozens of research papers appearing in scientific journals — the main discovery one boasts a whopping 3,500 co-authors.

Those discoveries include:

the first time light and gravitational waves have been seen simultaneously;

the first neutron star merger ever seen;

confirmation that the heaviest elements are made in these mergers;

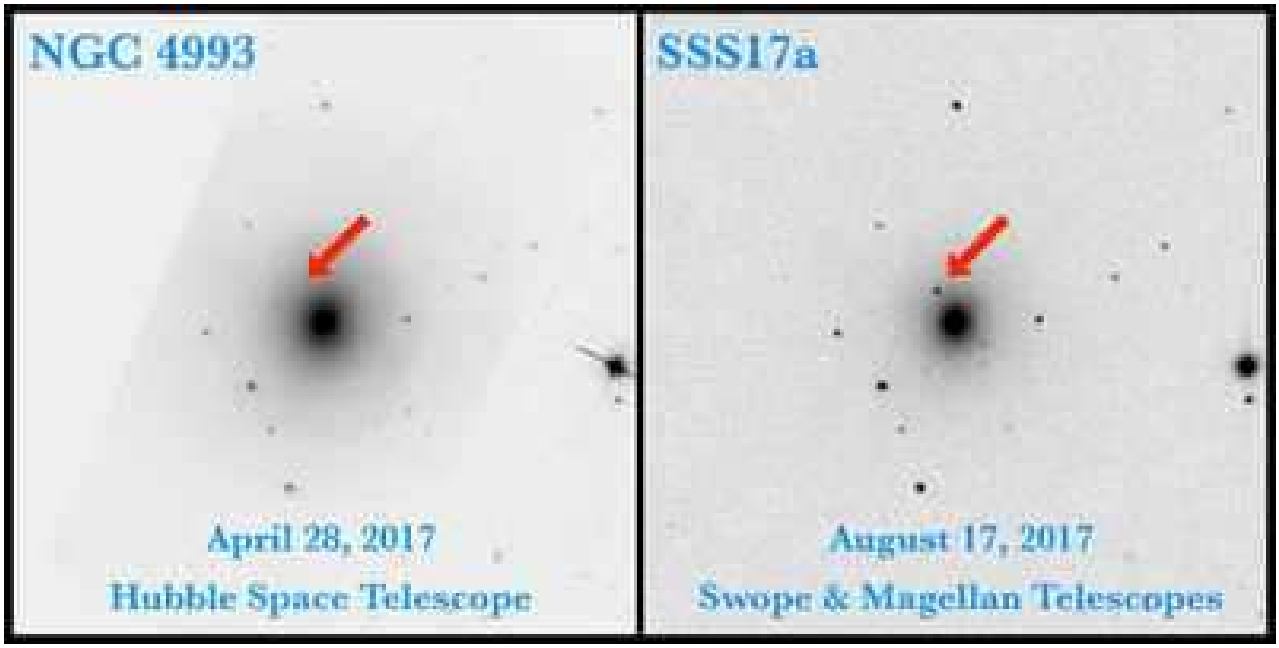
the first known location of a gravitational wave;

a direct measurement of the expansion of our universe;

best evidence yet that gravitational waves travel at the speed of light;

the best indication that gravitons – gravity carrying particles – have no mass, just like photons.

Whew.



Carnegie Observatories' Swope telescope was the first to image the neutron star merger in optical light. It's a small, decades-old telescope at Chile's Las Campanas Observatory. (Courtesy Ryan Foley)

A Race For Photons

Ryan Foley and his partner were wandering Copenhagen's historic Tivoli amusement park on what turned out to be an explosive Aug. 17. They'd been in Denmark for a month at a

gravitational waves conference but Foley, an astronomer at the University of California, Santa Cruz, had yet to see the sights on his trip. It was a day to relax; a text message would change that.

It was from Foley's grad student, David Coulter. LIGO had caught a binary neutron star merger – and so had the Fermi spacecraft.

Foley says he was certain his apprentice was just screwing with him on his first day off. After all, the week before, Foley had sounded a pessimistic tone in a room of young researchers as he detailed his plan to use ground-based telescopes to catch any LIGO-detected neutron star mergers.

Foley left the amusement park and raced back to campus on his bike. If this was indeed the real deal, there were only a few hours to prepare before nightfall in Chile, where his Carnegie Observatories team had time on a small, 45-year-old telescope called the Swope. Because the signal came from a region of sky close to the sun, it would only be visible for a little while after twilight. And they'd be racing against observatories around the world.

THE POTENTIAL PAYOFF: A NOBEL PRIZE.

Coulter set to work creating a list of about 100 possible galaxies to target based on LIGO's estimates. Meanwhile, Foley called up two colleagues – Carnegie Observatory astronomers Josh Simon and Ben Shappee – who were each operating one of the twin 6-meter Magellan telescopes that night.

"When big things happen, you call in every favor you can get," Foley says. "You've only got one shot, you either view it or it's gone."

Meanwhile, back in Santa Cruz, team member Charlie Kilpatrick downloaded images of their targets. The three telescopes would quickly image each galaxy and send the data back to California. There, Kilpatrick would compare the new pictures to existing ones looking for signs of a cosmic explosion.

Just 20 minutes after twilight, the Swope telescope struck gold with its ninth image.

"Found something," Kilpatrick punched into a Slack group message. There was an enormous bright spot in the galaxy NGC 4993.
"Wow!" Foley replied.
Astronomers on the optical light discovery team used Skype and Slack to message across three continents as they imaged the sky. (Courtesy Ryan Foley)

LIGHTS, CAMERA, ACTION

As the target galaxy inched closer to the horizon, Shappee and Simon each turned their titan telescopes to capture its light spectrum – astronomers' method for capturing an object's chemical fingerprints.

Telescope operators usually don't let their instruments point so low for fear of over-rotating and breaking them. Shappee kept observing until the Magellan shut itself down.

"I've never seen telescopes point so close to the horizon," says UW-Milwaukee astronomer David Kaplan.

It's a good thing, too. Other telescopes also caught the event that night, but Foley's group caught the only spectra. That data went to Maria Drout, also from Carnegie Observatories, who processed it within half an hour, revealing a spectrum unlike anything astronomers had seen before.

All the Galaxy's Gold
You and me, my pet dog, the apple that fell on Issac Newton's head – we're all made from matter that's created in supernovas, which happen about once per century in our galaxy. We're standard star stuff. But supernovas create sparse amounts of heavy elements, like the gold and platinum on your wedding ring, or the uranium world leaders are always fighting over.

So how did all the heavy stuff get here?

"All the other elements on the periodic table we knew where they came from in the universe," says Columbia University astronomer Brian Metzger. Neutron star mergers were the leading contender.

Metzger predicted these collisions would form a "kilonova," an event 1,000 times brighter than a standard nova. And other astronomers had showed these kilonovas could produce huge amounts of the heaviest elements. The trouble is, no one had ever seen one. So a fundamental question has gripped astronomers for decades.
"Is it the really common thing that makes a little? Or is it the rare thing that makes a lot?" says Kaplan, a co-author on research appearing Monday in the journal Science.

That answer arrived on Aug. 17.

An artist's illustration of two colliding neutron stars. (Credit: NASA/Swift/Dana Berry)

By the time Foley's team caught the first images of the collision – just 11 hours later – the cloud of material had already expanded as far out as Neptune is from our sun. Those subatomic particles cooled pushed outward, and they started combining into heavier and heavier elements.
Astronomers involved in Monday's announcement say this one neutron star merger created somewhere between 10 and 100 Earth masses' worth of gold. And based on how often neutron stars collide, scientists can extrapolate to say there should be roughly something like 100 million Earths' worth of gold in the Milky Way galaxy.
"It's essentially a way to take a neutron star's material and turn it into gold," Metzger says. "And not just gold but platinum and uranium and anything you see at the bottom of the periodic table."

Considering that this collision happened 130 million years ago in its own galaxy, all those heavy elements have likely already mixed in with interstellar gas clouds that will someday form new solar systems like our own.

And here on Earth, this one event has settled decades of scientific debate. "At least for the heaviest elements, this issue has been put to bed," Foley says.

Multi-messenger astronomy is just getting started. When LIGO comes back online next year after another round of upgrades, scientists expect to see one of these mergers every month or so. In the years to come, that number could grow to once a week – though astronomers don't expect many more neutron stars to merge this close to home.

"We've created a new field of astronomy," Foley says. "We've been walking around for all of humanity being able to see the universe but not being able to hear it. Now we get both."

He adds: "It's even hard to predict where this field will go, but I can tell you now it's going to be exceptional."

<S><C><I><E><N><C><E>

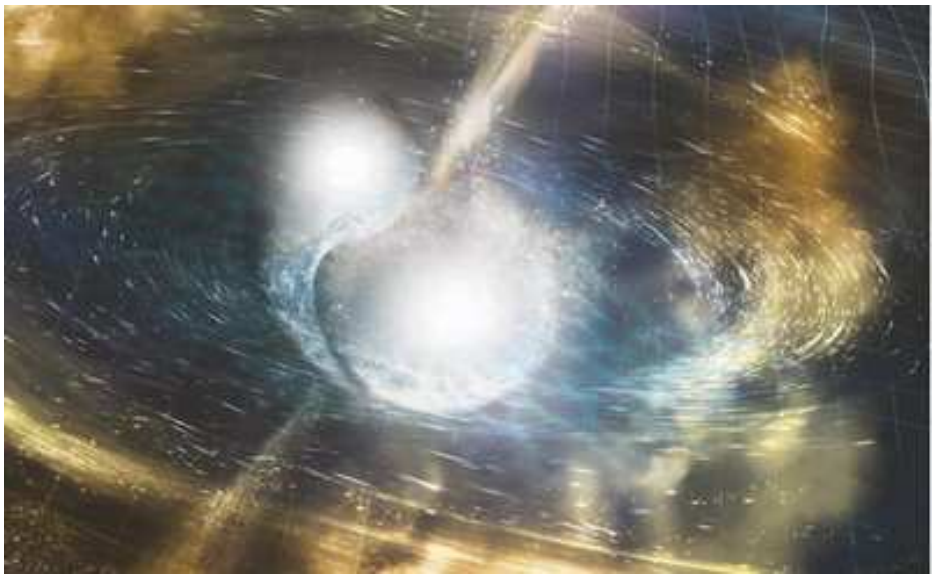
GRAVITATIONAL WAVE ASTRONOMERS HIT MOTHER LODE

Spacetime ripples from a stellar cataclysm in a distant galaxy help explain the cosmic origins of gold, and chart the course for a new age of "multi-messenger" astronomy

By Lee Billings on October 16, 2017
https://www.scientificamerican.com/article/gravitational-wave-astronomers-hit-mother-lode1/?utm_source=newsletter&utm_medium=email&utm_campaign=daily-digest&utm_content=link&utm_term=2017-10-16_featured-this-week

Ushering in the beginning of a new era in astronomy and physics, scientists on Monday announced they have for the first time detected the spacetime ripples known as gravitational waves from the collision of two neutron stars. Streaming in from the sky over the Indian Ocean on August 17, the waves registered at the twin detecting stations of the U.S.-based Advanced Laser Interferometer Gravitational-Wave Observatory (LIGO) as well as a European detector called Virgo located in Italy. This is the fifth time in the last two years that scientists have confirmed spotting such waves, a phenomenon that Einstein first

predicted more than a century ago—and that led to this year's Nobel Prize in Physics for three of LIGO's leaders.



Artist's illustration of two merging neutron stars. The rippling spacetime grid represents gravitational waves traveling out from the collision, while the narrow beams show bursts of gamma rays expelled just seconds after the gravitational waves. Ejected clouds of glowing, neutron-rich material swirl around the merging stars. Credit: NSF/LIGO/Sonoma State University/A. Simonnet

All of the previously detected gravitational waves, however, came from merging pairs of black holes. These objects are so dense that light cannot escape their grasp, making such mergers essentially invisible to normal telescopes despite the prodigious gravitational waves they generate in the final moments of their incredibly violent death spirals. Without a much-larger network of gravitational wave observatories, astronomers cannot pin down the precise locations of merging black holes, let alone deeply investigate them.

But neutron-star mergers begin with objects that in comparison with black holes can be featherweights. A neutron star is the highly compressed core of an expired massive star, and is formed in the aftermath of a supernova explosion. Its gravitational field is strong enough to squeeze and break down an entire sun's worth of matter into a city-size orb of neutrons, making it less a true "star" and more an atomic nucleus as big as Manhattan. But a neutron star's gravity is still too weak to trap light. So the flash from two of them slamming together can escape into the cosmos, producing not just gravitational waves but also one of the universe's most brilliant fireworks displays for anyone who cares to look.

In this case, after the initial chirp of gravitational waves signaling the onset of the merger, the "fireworks" consisted of a two-second-long gamma-ray burst (GRB) followed by a weeks-long, multi-wavelength afterglow—and "anyone" proved to be nearly every astronomer and physicist on Earth who had found out about the event. Julie McEnery, project scientist for the Fermi Gamma-Ray Space Telescope, which spotted the GRB, called August 17 "the most exciting morning of the nine-year Fermi mission."

The astronomers working with the LIGO and Virgo physicists had been sworn to secrecy. But the sheer volume of follow-up observations around the world unavoidably spawned public rumors, now confirmed, about a global campaign to track the collision and its aftermath. The resulting frenzy of new observations and theories is the most potent example yet of "multi-messenger" astronomy, an emerging field in which light, gravitational waves and subatomic particles emitted from astrophysical cataclysms are collected and studied in unison.

In an overwhelmingly mammoth series of papers published simultaneously across several journals, researchers are linking the latest event to a vast range of phenomena and providing fresh insights on everything from fundamental nuclear physics to the large-scale evolution of the universe. Among other things, the merger gave observers a front-row seat at the birth of a black hole, which the colliding neutron stars likely produced. The discovery that most glitters, though, is smoking-gun evidence that neutron star mergers—rather than run-of-the-mill supernovae—are the cosmic crucibles that forge the universe's heavy elements: substances including uranium, platinum and gold.
So it looks as if the radioactive pile in a nuclear reactor, the catalytic converter in your car and, yes, the precious metal in your wedding band may all come from the smashed-up innards of the universe's smallest, densest and most exotic stars—or at least whatever fraction can escape without falling into a merger's resulting black hole. The result could solve an ongoing debate over the cosmic origins of heavy elements that has possessed theorists for more than half a century. The bulk of the universe's hydrogen and helium was produced in the first moments after the big bang, and most of the lighter elements—oxygen, carbon, nitrogen and so on—were formed from nuclear fusion in stars. But the origin of the heaviest elements had been a lingering question until now.

"We have hit the mother lode!" says Laura Cadonati, an astrophysicist at Georgia Institute of Technology and LIGO's deputy spokesperson. "This is really the first time we have multi-messenger detection of a single astrophysical event, where gravitational waves are telling us the story of what happened before the cataclysm and the electromagnetic emissions are telling us what happened after." Although presently inconclusive, Cadonati says, analyses of the event's gravitational waves could eventually reveal details of how matter "sloshes around" within neutron stars as they merge, giving researchers a new way to study these bizarre objects and learn just how big they can get before collapsing into a black hole. Relatedly, Cadonati notes, there was a mysterious gap of about two seconds between the end of the gravitational-wave chirp and the onset of the GRB—an interval, perhaps, in which the structural integrity of the combined neutron stars briefly resisted the inevitable collapse.

For many researchers the breakthrough has been a long time coming. "My dream has come true," says Szabolcs Marka, an astrophysicist and LIGO team member at Columbia University who was an early proponent of multi-messenger astronomy in the late 1990s. Back then, he recalls, he was seen as "that crazy guy" trying to prepare for follow-up observations on gravitational waves—a phenomenon that was then still decades away from direct detection. "Now, I and others feel vindicated," Marka says. "We have studied this system of colliding neutron stars in a very diverse set of messengers. We have seen it in gravitational waves, in gamma rays, in ultraviolet, visible and infrared light, and in x-rays and radio waves. … This is the revolution—the evolution—of astronomy that I first hoped for 20 years ago."

France Córdova, director of the National Science Foundation, or NSF (the U.S. federal agency that supplied the bulk of LIGO's funding), calls the observatory's latest achievement a "historic moment in science" that could not have come without decades of sustained governmental support for a variety of astrophysical observatories. "The detection of gravitational waves, from the first short chirp heard round the world to this latest, longer chirp, not only validates the kind of high-risk, high-reward investments that the NSF makes but also spurs us to want to do more," Córdova says. "My hope is that the

NSF will continue to support innovators and innovations that will transform knowledge, and inspire many generations to come."

THE GOLDEN OPPORTUNITY

After the initial detections of the merger's gravitational waves and its subsequent GRB (the latter of which was immediately observed by the Fermi and Integral space telescopes), the race was on to find the collision's source—and hopefully its afterglow—in the sky. Within hours multiple teams had marshaled available telescopes to stare at the region where LIGO's and Virgo's scientists had calculated the source must be: a swath of the heavens spanning 31 square degrees and containing hundreds of galaxies. (Using LIGO alone, Cadonati says, the search would have been like "looking for the glimmer of a gold ring in the Pacific." With the addition of a third data point from Virgo, she says, the researchers could properly triangulate the source's position, reducing the search to something more like seeking "a gold ring somewhere in the Mediterranean.")

The bulk of the observations took place at observatories in Chile as soon as the sun had set and the crucial region of sky drifted up over the horizon, with different teams adopting an assortment of search strategies. Some simply "tiled" the region with observations, moving methodically from one side to the other; others targeted subsets of galaxies that theories suggested would be most likely to host a neutron star merger. In short order, the targeting strategy won out.

First to actually see the optical afterglow was Charles Kilpatrick, a postdoctoral researcher at the University of California, Santa Cruz. He was sitting at his desk and sorting through images of selected galaxies at the behest of one of his coworkers at Santa Cruz, the astronomer Ryan Foley, who had helped organized the campaign. In the ninth image he examined, hastily taken and transmitted by colleagues half a world away using the meter-wide Swope Telescope at Las Campanas Observatory in Chile, he saw it: a bright blue dot embedded in a giant elliptical galaxy, a 10-billion-year-old swarm of old, red stars about 120 million light-years away, nameless save for catalogue designations. Such galaxies are thought to be the main cosmic homes for neutron star mergers due to their advanced age, stellar density and relative lack of recent star formation. A side-by-side comparison with earlier images of that same galaxy showed no such dot; it was something new and recent. "It very slowly dawned on me what a momentous occasion this was," Kilpatrick recalls, "but I had tunnel vision at the time, just trying to work as quickly as possible."

Kilpatrick notified other team members including Josh Simon, a Carnegie Observatories astronomer who rapidly obtained a confirmation image with one of the larger 6.5-meter twin Magellan telescopes in Chile. The blue dot was there, too. Over the course of an hour, Simon followed-up by measuring the dot's spectrum—the various colors of light it emitted—in a pair of five-minute exposures. Those spectra could prove useful for further study, he reasoned—or if nothing else they could serve to ensure the blip was not an ordinary supernova or some other cosmic imposter. Meanwhile other teams had spotted the dot and were embroiled in follow-ups of their own. The rapid confirmation and spectra from Foley's team, however, clinched provenance for them. "We had the first image of this, and we have the first identification of the source in this image," Simon says. "Because we obtained both of those so early, we were also able to get the first spectrum for this merger—which no one else in Chile was able to do that first night—and then we issued the first announcement to the rest of the community."

Those early spectral observations proved vital for subsequent analysis and solving several mysteries. They showed the merger's leftovers rapidly cooling, fading from a brilliant sapphire blue to a dim ruby in the sky. These readings were verified over the next few weeks of observation as the visible dot faded, its afterglow shifting and peaking in cooler, longer-wavelength infrared light. The general pattern of colors, cooling and expansion hews close to what was predicted years earlier by a number of theorists working independently of each other, most notably Brian Metzger of Columbia University and Dan Kasen of the University of California, Berkeley.

In short, Metzger explains, what astronomers have seen from the merger's aftermath is something called a "kilonova": an intense outburst of luminosity created by the ejection and radioactive decay of white-hot, neutron-rich material from the neutron stars. As the material expands and cools, most of its neutrons are captured by the nuclei of iron and other heavy elements left over as ashes from the neutron star's formative supernova explosion, creating even heavier elements. "Over the course of about one second, as the ejecta are capturing these neutrons and expanding through space, one of these mergers will form the lower half of the periodic table—gold, platinum, uranium and so on," Metzger says. Near its conclusion, the kilonova's light dramatically shifts to infrared as the neutrons cascading through the ejecta forge the heaviest elements, which efficiently absorb visible light.

Measuring the kilonova's spectral evolution, in turn, allows astronomers to estimate the amount of different elements it has produced. Edo Berger, who studies kilonovae at the Harvard–Smithsonian Center for Astrophysics and oversaw many of the most ambitious follow-up observations of the merger, the event produced roughly 16,000 Earth masses worth of heavy elements. "That's everything—gold and platinum and uranium as well as all the weird ones you see just as letters on the periodic table and don't know their names," he says. "As for the breakdown? For that, I don't think we have exact answers yet."

Some theorists have suggested only a few tens of Earth masses of gold were made in the merger. Metzger, for his part, pegs the merger's gold output at roughly 100 Earth masses, with about three times more platinum and 10 times less uranium. In any case, when paired with updated statistical estimates of how often these mergers must occur, based in part on the latest detection, "you get a high enough rate per galaxy per year to build up the elements that form our own solar system and the abundances we see in other stars," Metzger says. "All that stuff we see, you can explain through these mergers. There may be other ways to make heavy elements, but you don't seem to need them." On average, he says, probably only one neutron star merger occurs in the Milky Way every 10,000 years.

THE FAR FRONTIER

What's more, studying exactly how a merger's kilonova evolves can convey crucial information about how the collision unfolded. For instance, the light from this merger's initial emission was bluer than expected, suggesting to Metzger and others the kilonova was being viewed at an angle rather than face-on. In this scenario the early blue emission would come from a spherical shell or equatorial band of relatively neutron-poor material blown out from the neutron stars at perhaps 10 percent light-speed. The later, redder emission would emerge from very neutron-rich material ejected at two to three times higher speeds from the neutron stars' poles as they collided, like toothpaste squirted from a tube.

Paired with detailed x-ray and radio observations, this scenario helps explain the curious nature of the gamma-ray burst associated with the merger—the closest GRB ever seen, but also one of the faintest. Short GRBs are thought to be bipolar jets of intense radiation spun up and ejected at nearly light-speed by churning magnetic fields within colliding neutron stars as they coalesce and collapse into a black hole. Viewed face-on—down the barrel of the GRB gun, so to speak—they are extremely bright. This is the case with the majority of such bursts that astronomers witness in the distant universe. But if they are tilted or inclined from our perspective they would appear rather dim and would only be detectable if they were relatively close, within several hundred million light-years.

Using the wealth of data available from multi-messenger astronomy, then, astronomers could eventually determine the viewing angles of many kilonovae throughout the observable universe, making each one a more potent marker for measuring large-scale cosmic structure and evolution. This could allow scientists to better confront a mystery arguably deeper than the origin of the heavy elements: the baffling fact that the universe is not merely expanding, but accelerating at an ever-increasing rate under the influence of a kind of cosmos-spanning anti-gravity known as dark energy.

Cosmologists hope to better understand dark energy by precisely measuring its effect on the universe, tracking objects in ever-more-distant regions of the universe to see how far away they are, and how fast they are moving, caught up in dark energy's accelerating flow. But to do this they need reliable "standard candles," objects with known brightness that can be used to calibrate this vast, sweeping view of spacetime. Daniel Holz, an astrophysicist and LIGO collaborator at the University of Chicago, has demonstrated how merging neutron stars could contribute to this effort. His work shows the strength of this latest merger's gravitational waves and the emissions of its kilonova can be used to calculate the local universe's expansion rate. Limited to just one merger, the technique yields a value with significant uncertainties, albeit still in the ballpark of the expansion rate obtained from other methods. But in coming years—as gravitational wave observatories and a new generation of large telescopes on the ground and in space work together to identify hundreds or even thousands of neutron star collisions per year—those estimates will markedly improve.

"What all this means is that the gravitational waves from these mergers measured by LIGO and Virgo are complementary with modeling of kilonovae that suggests their inclination, their viewing angle, by their spectral evolution from blue to red," says Richard O'Shaughnessy, an astrophysicist and LIGO team member at Rochester Institute of Technology. "That is a powerful synergy. If we know the inclination, we can know the distance, and that helps us with cosmology. What has been done here is a prototype for what we will be doing regularly in the future."

"If you think about it, the universe is sort of a cosmic particle collider, with neutron stars as the particles," O'Shaughnessy says. "It throws them together, and we now have the opportunity to see what comes out. We are going to see so many of these in the coming years—how many, I can't tell you, but people already describe it as a 'rain.' This event is a Rosetta stone, giving us real data to connect disparate threads of astrophysics that previously only existed in the mind of theorists or as bits in a supercomputer simulation. It allows us to understand the cosmic abundance of heavy elements. It allows us to probe the squishiness of nuclear matter at extreme densities. It allows us to measure the expansion of the universe. These synergies set the agenda for all of high-energy astrophysics for decades to come, and are built on decades of investment. We are now reaping the reward, a

mountain of gold 10 or a hundred times the mass of the Earth, that the universe just gave us."

If you would like to unsubscribe From: THE REVENGE OF HUMP DAY, please send an email message to Tim Bolgeo tbolgeo@epbfi.com and say, "QUIT SENDING ME THIS STUPID RAG!"
