



Inspiring Future Scientists and Engineers

AFRL NM STEM ACADEMY

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The Rocket Report

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In partnership with:



Collaborator:



Remember, Teachers:

It's never too early to make bussing arrangements for our classes and events!



LAVA LAMP Jack-O-Lantern!

You'll need:

- A clear plastic or glass bottle or jar
- A bottle of vegetable oil
- Water
- Alka Seltzer
- Food Coloring



Instructions:

- Fill the bottle about a quarter full with water. Top up to near the top with vegetable oil.
- The oil and water should separate into two layers, water at the bottom and oil on the top.
- Once the oil and water have separated, add enough food coloring to get the color you want. The color will mix with the water at the bottom.
- Pop in half an alka seltzer tablet and watch the bubbles.
- Add more alka seltzer little by little to keep the bubbles rising and falling.

For more Halloween STEM challenges, see www.science-sparks.com



Nothing Can Stop S&T Day at the Fair

Friday, 17 September 2021 was Science and Technology (S&T) Day at the New Mexico State Fair, and the Force was with us!

Nothing was going to stop us from attending THAT! We drove our “Darth Vader Van” down to the Fair and set up a booth, where students and visitors got to make Paper Circuit Lightsabers.



KOB-TV4 Meteorologist Eddie Garcia even came by and explained things for his viewers, while deftly wielding a lightsaber of his own like a trained Jedi!

Our booth was next to the US Forest Service’s...so now we know that Papa Cupcake is bigger than a bear!



They also got to scan a QR code linking to a video showing how the Air Force Research Lab (AFRL) works with real-world “lightsabers” in the lab, studying how charged particles interact with satellites in space.



Laboratory Lightsaber

It's contained in a vacuum chamber and plugged into a wall, but otherwise, AFRL's charged particle plasma beam is much like a *Star Wars* lightsaber. Both particle beams have enough energy to cut through many materials.

AFRL uses it to study how charged particles interact with satellites in space at high speed.



Scan the QR code with your smartphone camera, or QR code reader app, to link to a YouTube video demonstrating AFRL's version.

Action figures sold separately.



The Fair...The Force...

Like they say...

Nothing can stop the US Fair Force!



Retract That

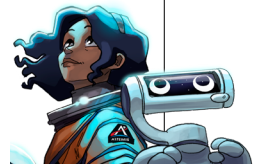
Mr. James “Hacksmith” Hobson, of Hacksmith Industries, recently set a Guinness World Record, creating the world's first *retractable* plasma-based lightsaber (www.guinnessworldrecords.com)!

Dream to Reality

Speaking of QR codes...NASA is creating a series of QR code accessible interactive “graphic novels” (interactive comic books) called “First Woman.”



They tell the tale of the fictional character Callie Rodriguez, first woman to explore the moon, and her robot sidekick, RT.



Based on the upcoming Artemis mission, Issue #1 is called *Dream to Reality*. From her childhood dream of space travel to being selected as an astronaut candidate, Callie takes us on her journey to the moon.



Mission to Mars

For Fifth Graders

Mars Vast Interferometer Variable Array (VIVA) Mission 2021-2022

Viva STEM!

Background

Reflecting telescopes are measured by the diameter, or *aperture*, of their primary mirror. Bigger mirrors, better images.

For example, AFRL's Starfire Optical Range (SOR) telescope, built in the mid-1990s, which pioneered the use of *adaptive optics* to compensate for atmospheric distortion, has a 3.5 meter mirror.

More recently, two telescopes being built under the US's Extremely Large Telescope program are the 24.5 meter Giant Magellan Telescope (GMT), and the Thirty Meter Telescope (TMT).

The 6.5 meter James Webb Space Telescope (JWST), scheduled to launch near the end of 2021, is bigger than the 2.4 meter Hubble Space Telescope (HST).

But even with these telescopes, planets and objects a mere 100 light-years away will be just a tiny pixel of light. To get a good look at objects that far away requires a really big, or *vast*, *interferometer variable array* of space telescopes.



Mars Vast Interferometer Variable Array (VIVA) Mission 2021-2022

An *interferometer* combines the light from an array of two or more separate telescope mirrors to simulate having one *giant* mirror.

Controlling the variable distance between the telescopes, effectively changing the "diameter" of the simulated "giant mirror," adjusts the image quality. Farther apart (larger diameter) makes it *sharper*, closer together (smaller diameter) makes it *brighter*.

Mission Objective

This year's simulated mission objective has scientists, working from a base on Mars, control and operate a *vast interferometer variable array* of AFRL Space

Vehicles (RV) and Directed Energy (RD) Directorate-designed space telescopes, spread out in a precisely laser-aligned web in the space between the asteroid belt and the orbit of Jupiter (for a better view).

How vast? The satellite telescopes can spread apart from each other to make one super-telescope with a potential effective diameter of over *150 billion meters* (about 1 Astronomical Unit, or AU, the average distance from Earth to the Sun), and still have about *half an AU* of *wiggle room* on either side!

Scientists and engineers responsible for supporting the **Mars Vast Interferometer Variable Array (VIVA) Mission** will require a colony of long-term living quarters and food on Mars.

Fifth grade students participating in the 2021-2022 Mission to Mars will plan and build the necessary facilities and life support resources, and present them at the culminating Link-Up Day event in the spring.

VIVA STEM!



Your **commitment** to this mission is crucial to its success

Returning, New

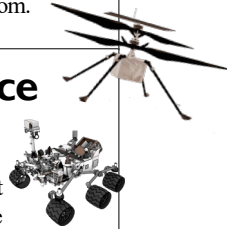
Returning Mars teachers, *welcome back!* There's a virtual "refresher course" scheduled for **Tuesday, 19 October 2021.**



For teachers *new* to the Mission to Mars, there's an *in-person* training for new teachers at our facility on **Tuesday, 9 November 2021.**

To register for the Mission to Mars this year, go to the www.afrlnm.com/stem/missions/mission-to-mars page, and click the Registration button near the bottom.

Perseverance Pays Off



It's only been about eight months since the *Perseverance* rover landed in the Jezero Crater on Mars, and already it has:

- Collected Martian rock core samples,
- Flown the *Ingenuity* helicopter, and
- Gotten the first scientific results about the Jezero Crater delta published.



DoD STARBASE NM

For Fifth Graders

By the Tuesday of the week before the first class in the series, session, or semester, we will ask you for the name, driver's license number/ state of issue, date of birth, and the FULL Social Security Number, of every adult coming through the base gate for that series of classes.

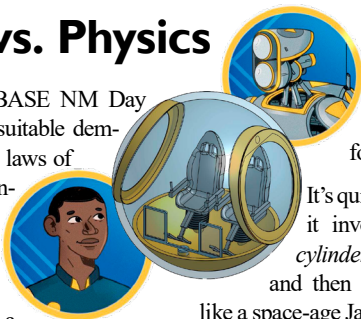
Magic vs. Physics

In DoD STARBASE NM Day 2, Physics, any suitable demonstration of the laws of physics is indistinguishable from magic.

Otto's Gyro

Otto works at a factory manufacturing "gyrosphere" modular transportation cockpits, with help from his robot assistant, Gary.

Using the magic of *Onshape* 3D Computer Assisted Design (CAD) software, DoD STARBASE NM Day 2 students



help Otto and Gary get the next gyro-sphere ready for delivery!

It's quite the procedure; it involves *filetting* a *cylinder* into a *sphere*, and then *hollowing* it out like a space-age Jack-O-Lantern.

May the Force be With You

The prophecy said that young Anakin Skywalker would be the one to bring balance to The Force.

But Jedi master Sir Issac Newton said that *motionless* an unmoving object inertia would keep, unless

an *unbalanced* force acted upon it was, *hmmmmmm?*

Day 2 padawans use this Physics factoid to go all Jedi with the Tablecloth Trick, albeit with plastic cups instead of Grandma's best china. See? Indistinguishable from *magic*.

Fizz Whiz

TABLECLOTH TRICK



In the Pop Goes the Fizz activity, students use an Alka-Seltzer-powered rocket to essentially run

a scale model version of a little William Shatner trying to pass the Kármán line in a tiny Blue Origin spaceship.

New Flame

Blue Origin's origin? The *Blue Flame* rocket dragster could go *622 mph* back in the day!

The custom-designed little wooden CO₂-powered dragsters the students race in Day 2 don't get going quite that fast, but they still go pretty quick, depending on how much CO₂ is in their fuel cartridges.

Look out, land speed record, here we come!





TECH Mission For Middle Schoolers

Technology and Engineering Challenges—Rocketry and Satellites Missions

By the Tuesday of the week before the first class in the series, session, or semester, we will ask you for the name, driver's license number/ state of issue, date of birth, and the FULL Social Security Number, of every adult coming through the base gate for that series of classes.

Let's Build a Rocket!

The first of the three little pigs built his house out of *straw*. Besides not being up to code, when Big Bad Wolf showed up, all he had to do was huff and puff and he ended up blowing the whole thing down. First windy day came along probably would've done the same thing.

TECH Mission Day 1 middle school students have a better idea: Forget three little pigs housing. Let's build *rockets* out of straws!

Students engineer straw rockets that can travel 5 meters and hit a target, factoring in the length and mass of the straw, angle of launch, height of launching plunger, fin shape, num-

ber of fins, and so on.

Pig #3 built a sturdier house out of brick. TECH Day 1 students build bigger, sturdier four foot tall rockets to launch on Day 2. Brick's thick, so they use plastic and metal components to assemble the *booster tube*, *payload*, and *motor mount* sections.



They never said the name of the three pigs, but the students choose a *rocket name* from cool options such as *Gemini*, *Atlas*, *Phoenix*, and *Apollo*. They simulate its flight with a software program called *RockSim*. See, with *HouseSim*, pig #1 would've known ahead of time that stucco is way better.

Day 1 TECH students also go hi-tech and explore global positioning satellite (GPS) rocket tracking.

Day 2: Launch Tips

Teachers, if weather looks bad on launch morning (**26 October 2021**), verify launch is still a "Go." Call the

Rocket Launch Hotline at (505) 401-5456. *Note:* Our office is closed on Rocket Launch Day. We'll all be out at the launch site!

When getting ready that morning, consider weather appropriate **layers, bottled water, sunscreen**, appropriate desert **footwear**, and **sun hats**. Don't forget to bring lunch for the day!



At the launch site, *safety first!* Teams monitor weather and wind conditions, making sure the wind doesn't huff and puff too much. Teams stay in assigned areas, and *everyone* stands during launch.



Robotics Challenge For Middle Schoolers

Finders Keepers

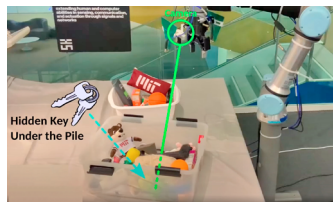
Robots are found in more and more places these days, and they keep finding new ways to be useful, even in the Pandemicky era we find ourselves in.

MIT researchers have found a way for health care workers to screen patients for Covid safely, using Boston Dynamic's "creepy robot dog" to measure patients' skin temperature, breathing and pulse rate, and blood oxygen saturation, from a "social" distance of 2 meters (over 6 feet!)



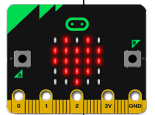
ISS astronauts will be finding themselves once again facing the free-floating face of hands-free robotics assistant CIMON-2 this month. He's been asleep since February 2020, but they fortified his connection to Earth so he'll interface with astronauts better.

For those that are always losing things—like car keys—just find yourself an RFusion robot from MIT, and you'll never be a loser again! With the help of its camera, and a radio frequency (RF) antenna on its gripper, this robotic arm can *find* and *retrieve* lost objects, like car keys, even if they're hidden under a pile of stuff.

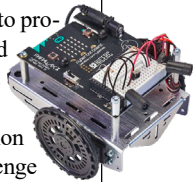


If all this finds you wanting to find out how you can get more involved in the robotics revolution, try the Robotics Challenge mission, spinning up in November.

Students find the difference between binary and decimal numbers to get a micro:bit microcontroller.



Once they find out how to program *that*, they'll find themselves with a robot they can assemble and plug it into, in preparation for The Robotics Challenge Expo event.



STEM Challenge For High Schoolers

Team Name and Logo

Suggested Timeline: Sep/Oct

Think about the STEM Challenge you are working on and the qualities each member of the team possesses.

Decide on a team name, develop a logo to represent your team, and create an electronic version of that logo.



Teams submit an electronic version of the logo to the online learning management system (LMS) for points.

Team name and member names must be explicitly listed either in the document containing the logo or the comments that accompany assignment submission.

Like This, See?

Here's some examples previous STEM Challenge teams have submitted.



Team 20--
Nerd Herd



Team 22--
Newton's Nemesis



Team 17--
Tigerpulters



Team 19--
Tigerseye



Team 21--
Small Fries

NUCLEAR EGGS



Team 23--
Nuclear Eggs



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<https://www.youtube.com/channel/UC-QuOSd1XTkYuXPONZwIAIHQ/videos>

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Mr. Steve Burke, Technical Writer.

Important Terms and Acronyms

AF: Air Force

AFB: Air Force Base

AFRL: Air Force Research Laboratory

AFRL NM: AFRL New Mexico (AFRL/RD and AFRL/RV), on KAFB

AFRL/RD: The Directed Energy Directorate of the AFRL

AFRL/RV: The Space Vehicles Directorate of the AFRL

DoD: Department of Defense

KAFB: Kirtland Air Force Base, Albuquerque, NM

MM: Mission to Mars

PRS: Phillips Research Site

S&Es: Scientists and Engineers

STEM: Science, Technology, Engineering, and Math

TECH: Technology and Engineering Challenges

USAF: United States Air Force

VIVA: Mars Vast Interferometer Variable Array Mission 2021-2022

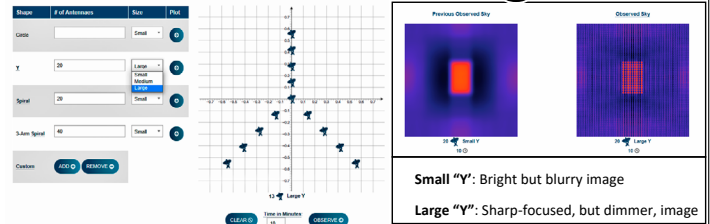
Remember, Teachers:
Get those EPA
Modification forms in!

Interactive Interferometer Investigation

In this year's simulated Mission to Mars, student astronauts are asked to build a Martian colony to support a *Vast Interferometer Variable Array*.

Our friends at the National Radio Astronomy Observatory (<https://public.nrao.edu/interferometry-explained/>) have put together a cool *interactive radio/telescope interferometer generator!*

You and your students can generate custom virtual interferometer arrays. Input different array configurations like Ys or Spirals, different sizes, and number of dishes, and then see how it affects a sample image.



1. Click **Choose Source Image**.
2. **Select a target** to look at, like the **rectangular grid of dots** on a dark background.
3. Click **Make Antennae Configuration**.
4. Enter a number of satellites (like, say the default, **20**) next to a configuration such as "Y."
5. Enter a size, like **Small**.
6. Click the round blue "Plot" button-arrow on that line. It will draw your satellites on the grid.
7. Click the blue "Observe" button below the grid. Now you see a bright orange blurry rectangle.
8. Click the blue "Back" button.
9. Change your selection to, say, **Large**.
10. Click the "Plot" button again. It redraws your satellites in their NEW, spread out, configuration.
11. Click the blue "Observe" button below the grid again.
12. Check the "Compare to Previous" checkbox.
13. Voila! It shows the results of your comparison.

On the left, the small "Y": You get a bright orange, blurry rectangle.
On the right, the large "Y": You see a grid of small, focused dots makes up the rectangle. Purple background is sharper, too. BUT, this rectangular grid of dots is not as bright as the blurry orange "small Y" rectangle is.

Ip Ip, Array!

The Vast Interferometer Variable Array (VIVA) would represent the latest in a long line of similar Earth-based large radio/telescope arrays.



The Very Large Array (VLA), near Socorro, NM, consists of 27 radio telescopes in a "Y" configuration, whose baseline can vary from 1 to 36 km.

Keep On Trekkin'

Star Trek keeps on trekkin' into the news.

Just when you thought Elon Musk had won the battle of the billionaires with his *Inspiration4* mission, Jeff Bezos strikes back by sending William Shatner (Captain Kirk) to boldly go where Bezos had gone before—the edge of space, in a Blue Origin capsule. Shatner, 90, is now the oldest human to go to space.

Meanwhile, Star Trek Voyager Vulcan actor Tim Russ, who played Lieutenant Com-

mander Tuvok, recently was one of five citizen astronomers who helped NASA find an asteroid called Patroclus.



The Atacama Large Millimeter/submillimeter Array (ALMA) is a radio telescope with 66 antennas and a baseline of over 16 km.

Newest military branch Space Force just introduced its new uniform, and everyone thinks it resembles the uniforms from *Star Trek II—The Wrath of Khan*...or else the 2003 remake of *Battlestar Galactica*. See www.space.com.



The Square Kilometer Array (SKA-Low) will consist of 132,000 antennas with baselines of up to 65 km. SKA-Mid will consist of 130 parabolic dish antennas, with a maximum baseline of 120 km.

The fictional VIVA array would have a potential effective baseline of over 150 billion meters.

Make a Note

STEM Santa Fe's STEM Pathways for Girls Conference (www.stemsantafe.org), for northern New Mexico 5th-8th grade girls. Live keynote YouTube presentations Friday, 29 October and Saturday, 30 October, 5:30 pm.

Kirtland AFRL Scholars (www.afrlscholars.usra.edu/locations/kirtland/dates.shtml) applications accepted starting mid to late October 2021.

Coming Next Issue...

- Mars is neighborly
- Rockets launched!
- STARBASE D3 Tech

Watch for it!

