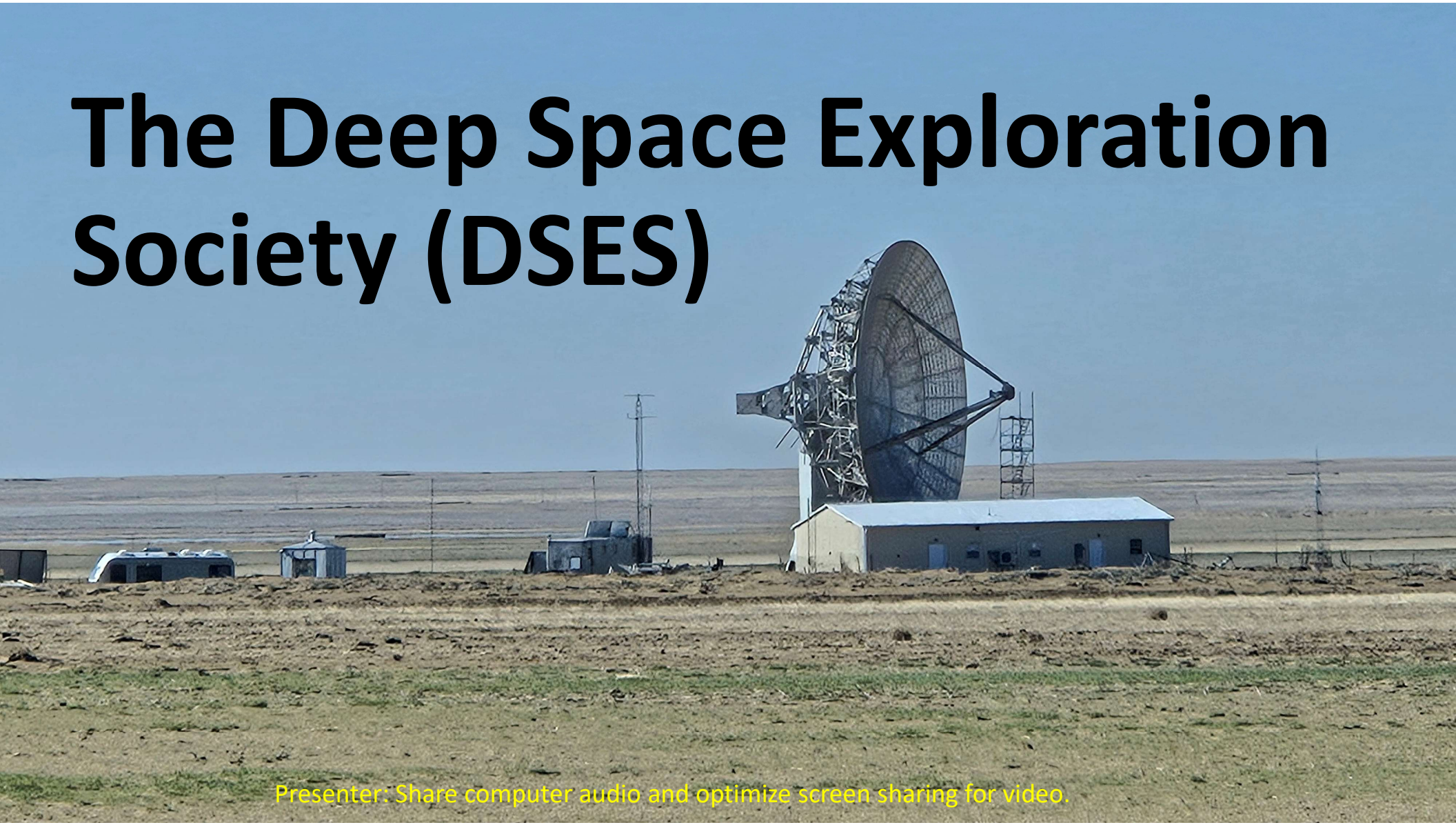
The Deep Space Exploration Society (DSES)



Presenter: Share computer audio and optimize screen sharing for video.

The Deep Space Exploration Society (DSES)

History, Radio Astronomy, Amateur Radio and STEM Education & Outreach

Roger Oakey / W3MIX
Paul Sobon / NOØT

2025/10/17 0912

Bill Miller, DSES VP, KCØFHN

Roger Oakey / W3MIX

w3mix@nankoweap.com

- Bachelor of Science in Computer Science from California Polytechnic State University, San Luis Obispo, California (1975-1980). Concentrations in electrical engineering and statistics.
- Retired software engineer specializing in high end storage (RAID and high availability) for Digital Equipment Corporation (DEC), Compaq, Hewlett Packard and Hewlett Packard Enterprise – all at the same desk, 1980-2017
- Amateur radio history
  - Technician 2006 (KCØVRW / KØRLO)
  - General 2015
  - Extra 2023 (W3MIX – “Trimix” – a technical SCUBA diving breathing gas)
- Not a super active ham (occasional POTAer)
- I joined the DSES in 2022, so I’m a relatively new member.
- I consider myself a Maker – I like to design and build stuff.
  …and boy, does DSES have a lot of stuff that needs to be designed and built!

Paul Sobon / NOØT

pauls@dses.science

- BSc Physics and MBA Business
- Amateur radio history
  - Licensed in 1964 as VE3FIB in Toronto
  - Held callsign VE2KV while in Montreal
  - Transferred to the US in 1981 and became NOØT in Minnesota
- Started the Front Range 6 Meter Group in 2021 with Bill Thomas, WTØDX
- Joined DSES in 2022, joined the board of directors in 2023, and became President in 2025.
- Favorite bands: 6 meters and 23 CM

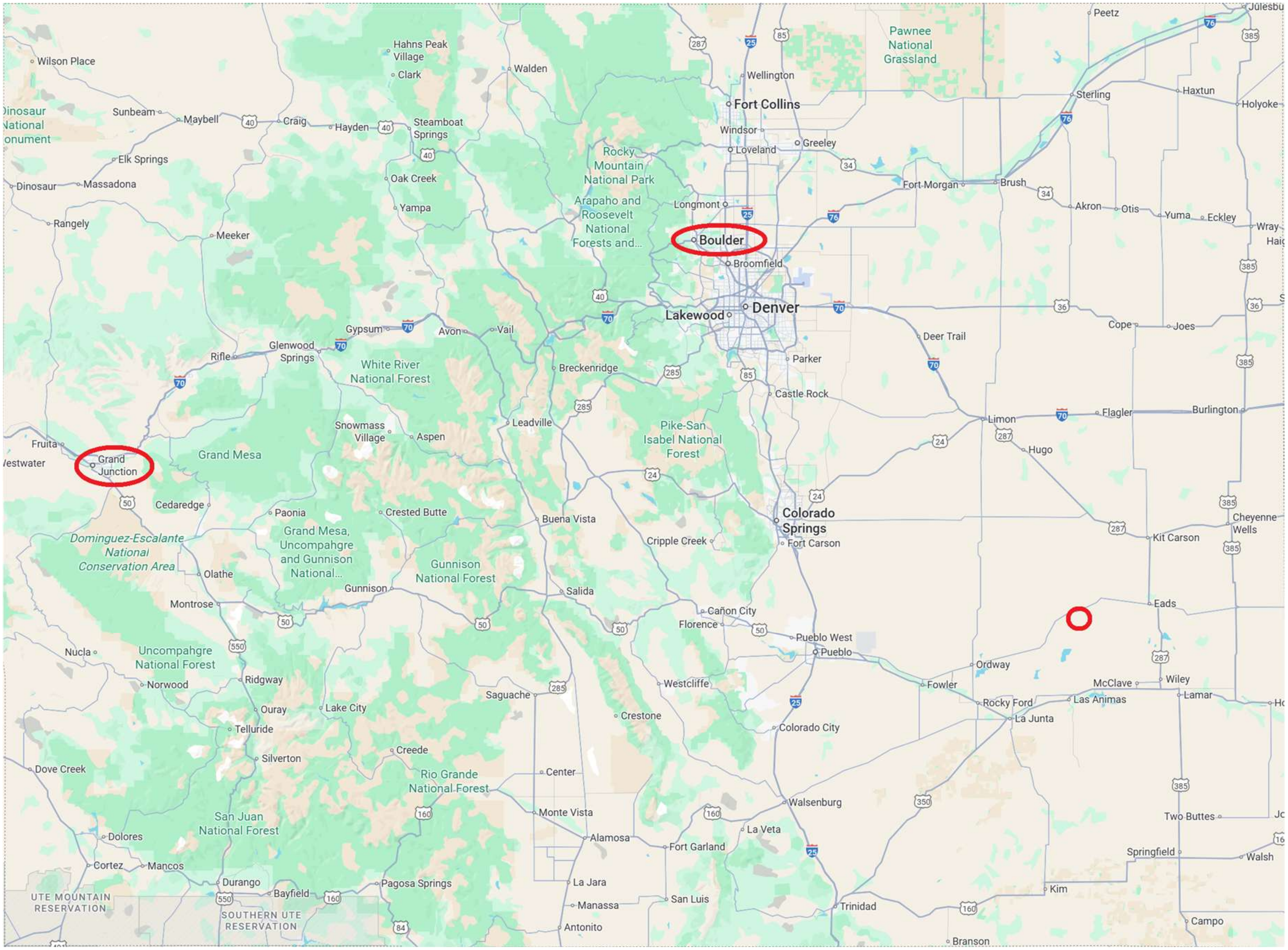
DSES Purpose (paraphrased from bylaws):

The Society is an advocate for the exploration and understanding of space through education, promotion of research and the development of standards and guidelines. DSES shall:

- Encourage knowledge and skills related to Science, Technology, Engineering and Mathematics (STEM).
- Encourage students and educators to actively take part in the exploration of space.
- Disseminate space-related information to the public at large and to educators and students in particular.
- Disseminate scientific and technical information derived from the Society's work through the publication of such information.
- Provide communications capability for space missions.

It’s a small step from amateur radio to radio astronomy – as a consequence almost all our members are hams!

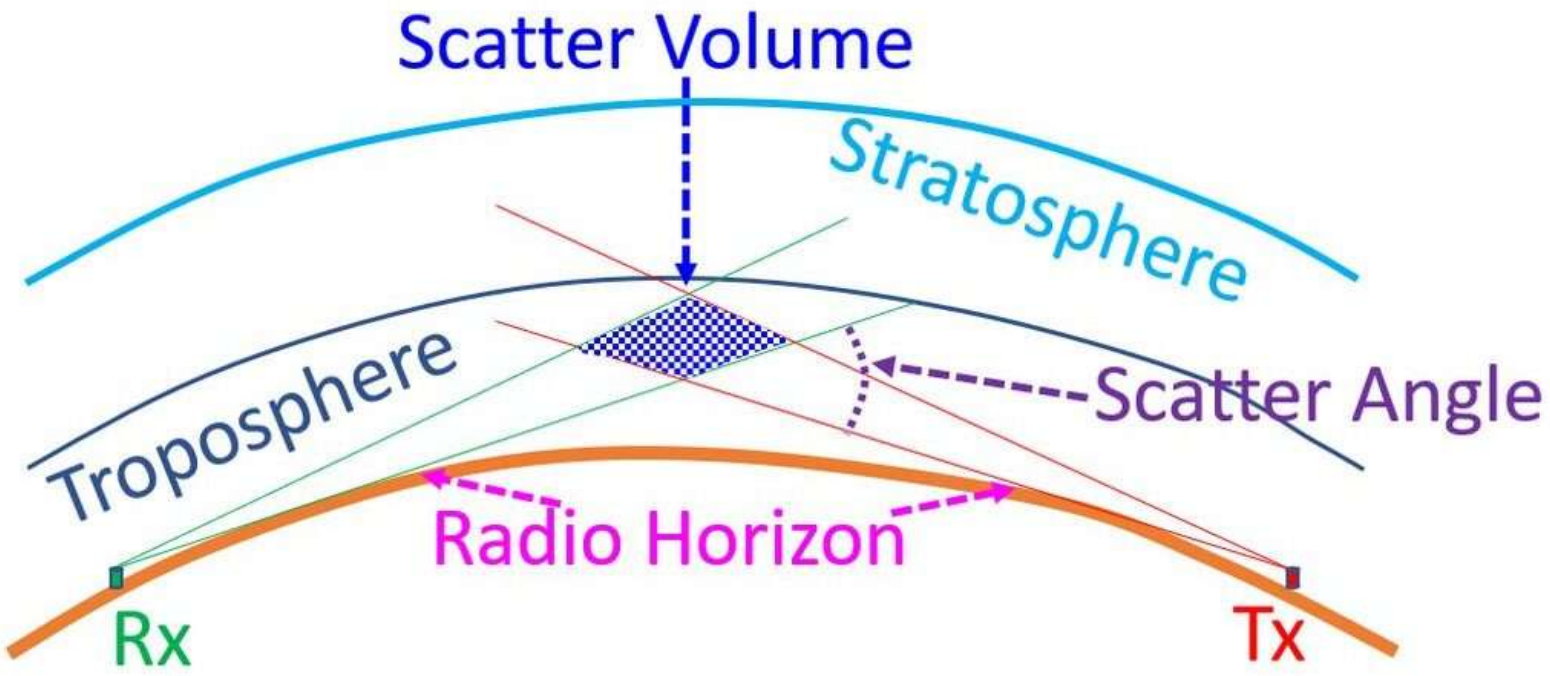
The DSES owns and operates a 60-foot (18.3m) dish antenna on Colorado's eastern plains just south of Haswell, Colorado.



Fort Collins
Boulder
Denver
Lakewood
Colorado Springs
Grand Junction
Pueblo
Rocky Mountain National Park
Pawnee National Grassland
Grand Mesa
White River National Forest
Pike-San Isabel National Forest
Gunnison National Forest
Rio Grande National Forest
San Juan National Forest
Uncompahgre National Forest
Dominguez-Escalante National Conservation Area

Dish Antenna History

- The twin 60-foot (18.3m) parabolic dish antennas near Boulder, Colorado and an identical dish in Haswell were part of a 1960's network of sites built for the Air Force by the National Bureau of Standards for their Central Radio Propagation Laboratory.
- Other antenna sites were located from Colorado to Arkansas.
- The antennas built to to study tropospheric scatter for *reliable* over-the-horizon communication.



Tropospheric scatter or “Troposcatter” allows *reliable* microwave communication beyond the horizon. It was developed in the 1950s and was used for military communications until communication satellites replaced it in the 1970s.

Ref: wikipedia.org/wiki/Tropospheric_scatter

Dish antenna history, continued

- Antenna sites were constructed starting in the late 1950s and operated until about 1974 when they became obsolete by satellite (and now fiberoptic) advances. No longer needed, the sites were sold at government auction.
- With the exception of the Haswell Colorado site, antennas at all the other sites were scrapped after the sites sold. Boulder is intact because it's still government property.
- The Haswell site remains only because Paul Plishner, a prominent radio and radar contractor, purchased it with the idea of rebuilding the site for commercial use. However, that endeavor proved unsuccessful.
- Therefore, the Haswell site lay dormant from 1974 until 2007 and fell prey to the elements, vandalism and theft of much of the infrastructure copper.

1972 Haswell NBS field site

500 foot tower, 3-phase 900 amp service
no longer at site.

DSES Organization History

- The DSES Organization was formed in 1991 in Boulder, Colorado.
- The National Telecommunications and Information Administration (NTIA), gave permission for the DSES to restore one of the unused 60-foot (18.3m) dish antennas North of Boulder.
- On September 11th, 2001 everything changed, and DSES members (civilians) were no longer allowed on government property.
- The DSES then approached Paul Plishner about using the Haswell site. He agreed and gave a no-cost lease to the DSES.
- In 2007 DSES moved all their equipment to Haswell, Colorado. After making significant restoration progress, Mr. Plishner *donated* the dish and property to the DSES organization!
- For this generous donation, the DSES has named the site:

  "The Paul Plishner Radio Astronomy and Space Sciences Center"

- Mr. Plishner passed away in 2016, but his generosity is still greatly appreciated by the organization, and his legacy will live on for many years as a space science and radio discovery educational center.

Radio Telescope / Dish Antenna Specification

- Shape: True parabola
- Frequency Range: 400 MHz to 2 Ghz, 10 GHz may be possible
- Diameter: 60 Feet (18.3m)
- Weight: 65 Tons (59t) [Estimated]
- Antenna Gain: 42.5 dbi at 1 Ghz
- Beam Width: 2.6 degrees at 400 MHz
  0.8 degrees at 1.2 GHz
- Coverage: Full Hemisphere with tracking control
- Max Slew Rate Az/El: 40 degrees per minute (9 minutes for a full 360 degrees Az)
- Noise Temperature: 1-2db at 400 MHz total system
- Noise Figure: 0.8db at 400 MHz w/20db LNA
- Maximum deviation from a true parabolic shape is no greater than ¼ inch (6mm) at any point on the dish with winds up to 30 mph (50 kph) and slightly reduced precision in winds up to 50 mph (80 kph).
- When stowed in the “birdbath” position, the antenna is capable of withstanding winds up to 120 mph (200 kph), with a maximum radial ice formation of three inches (7.5 centimeters).

As derived by Ray Uberecken
Communications Engineer

ADA compliant control room, classroom and garage,
thanks to an Amateur Radio Digital Communications (ardc.net) grant!

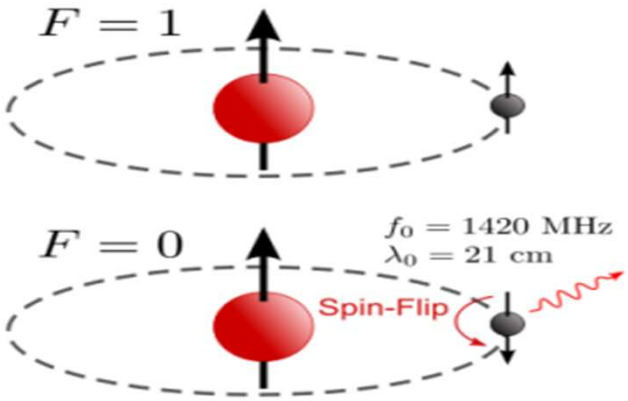
Radio Astronomy Projects

- **Hydrogen Line –** 1420 MHz Density Mapping of the Mily Way galaxy (radio-astronomy.org/store/projects/scope-in-a-box)
- **Pulsar Logging –** Currently revisiting pulsar detection and improving our equipment, processes and methodology (https://public.nrao.edu/radio-astronomy/pulsars/)
- **ScintPi –** Ionospheric scintillation and TEC (**T**otal **E**lectron **C**ontent)monitor (labs.utdallas.edu/rodrigues/scintpi/)
- **e-Callisto –** Solar radio spectrometry / coronal monitor (www.e-callisto.org/)

- **SAM-III – S**imple **A**urora **M**onitor is a 3-axis geo magnetometer. Measures the distortion of the Earth's magnetic field due to solar activity (https://www.reeve.com/SAMDescription.htm)
- **Radio Jove –** 15 MHz to 22 MHz Monitors radio signals from the interaction of Jupiter and its moon Io (https://radiojove.net/kit/order_form.html)
- **SuperSids –** 3-30 kHz **S**udden **I**onospheric **D**isturbance (SID) monitor: Captures significant solar flares and events (www.radio-astronomy.org/store/projects/supersid)
- **SETI –** 1.42 GHz Geographically-spaced Synchronized Signal Detection System with Greenbank and Plishner Radio Observatory (DSES)

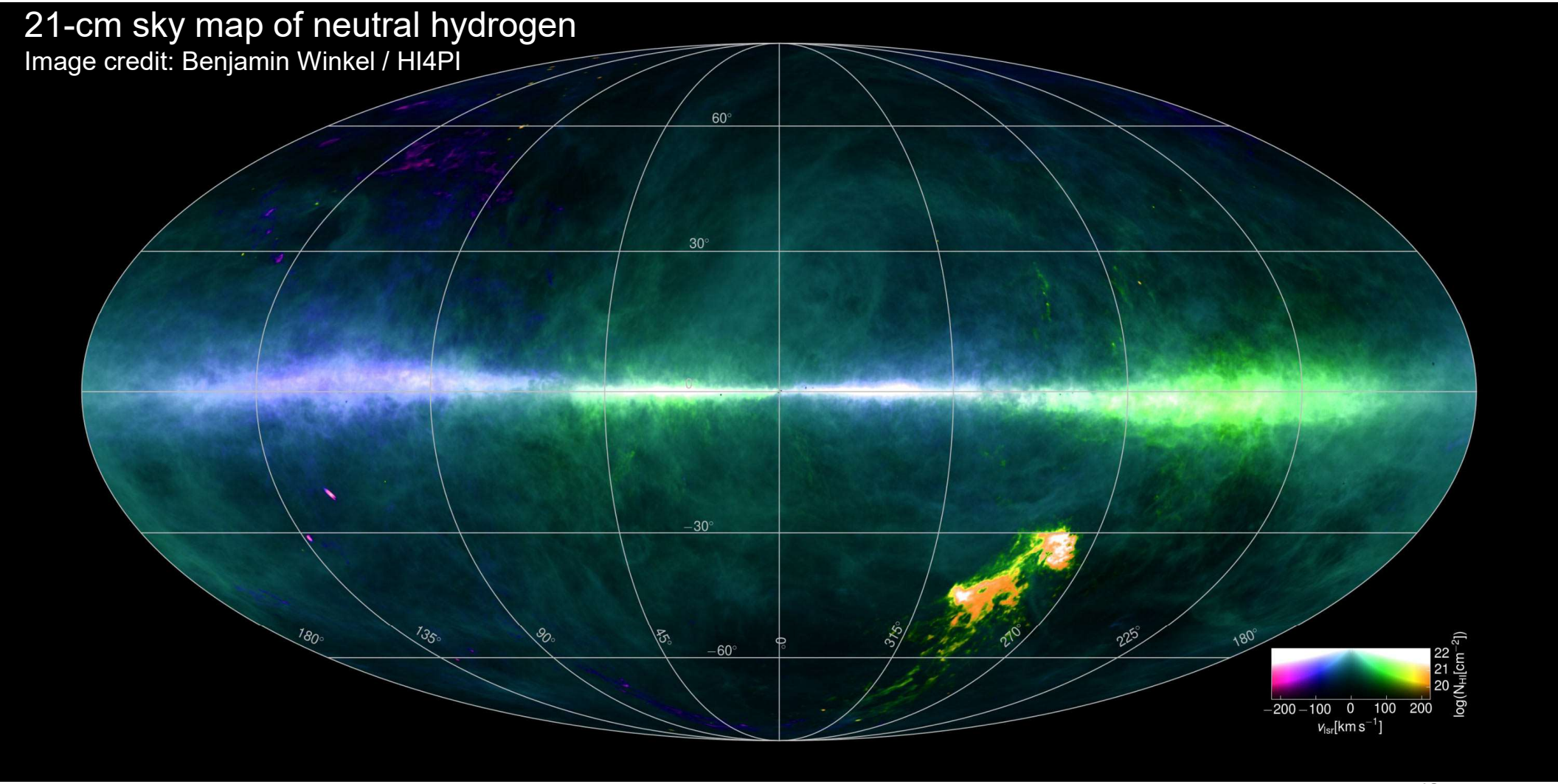
Neutral Hydrogen Emissions

- Hydrogen is the most abundant element in the universe, making up about 70% of all matter.
- Neutral hydrogen gas is the main component of the Interstellar Medium, much of it not at its lowest energy state.
- On average, once every 10 Million years a hydrogen atom not quite at its lowest energy state (F = 1) will “spin flip” its electron to get to its ground state (F = 0), emitting one photon at 1420.4MHz / 21cm (or 5.874μeV) which is Hydrogen’s “spectral line”.
- The spectral line’s luminosity is used to map the Hydrogen distribution within the Milky Way.
- The spectral line’s doppler shift is used to map the relative velocity of the Hydrogen.
- A small dish or horn antenna with an SDR is all you need (https://radio-astronomy.org).



21-cm sky map of neutral hydrogen

Image credit: Benjamin Winkel / HI4PI



Amateur Radio Projects

- **KØPRT –** Remotely operated all band, all mode, amateur radio station with multiple antennas. Donated by Paul Sobon, NOØT
- **EME –** 1296MHz 300W EME unit “Diane” used for several EME competitions (dubus.org/ and arrl.org/eme-contest) …and popular during our open house!
- **EVE –**1296MHz, 2kW system designed by Alex Nersesian, K6VHF

- **NASA Deep Space Network –** Receive signals from Voyager 1 (one light-day away) and other DSN objects (nasa.gov/communicating-with-missions/dsn/)
- **30-foot dish –** Disassembled antenna moved to site. Construction begins in 2026 (arrl.org/files/file/QST/This%20Month%20in%20QST/2025/april%2025/0425%20Hambly%20Free.pdf)
- **Towers –** Two new Rohn 45 antenna towers on either side of the building

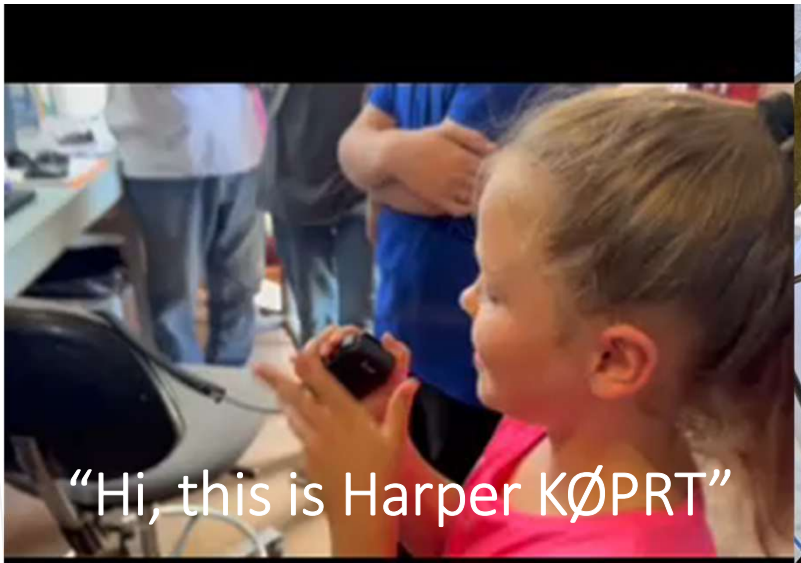
- **Meteor Scatter –** 30-100 MHz

Remotely Operated amateur radio station, KØPRT – “Plishner Radio Telescope”

- Remote operation requiring 2 monitors and 8 windows
- All HF and 6M Bands
- All Mode
- HF linear amplifier
- SDR enabled
- Automation of Equipment and Logging
- Quiet RF location enhances reception
- Future: Opening up use to all members

Earth-Moon-Earth (EME) Communication and Contesting

- ~280dB of path loss
- Original 150W 1296MHz transmitter by Ray Uberecken
- 4th place in 2020 ARRL multi-operator, all mode, 1.2 GHz
- Current 300W 1296 MHz transmitter by Alex Nersesian
- 2nd Place in May, 2023 DUBUS
- Strongest station in several EME contests
- The main attraction of ‘23, ‘24 and ‘25 DSES open house



Earth-Venus-Earth (EVE) – High Level of Difficulty

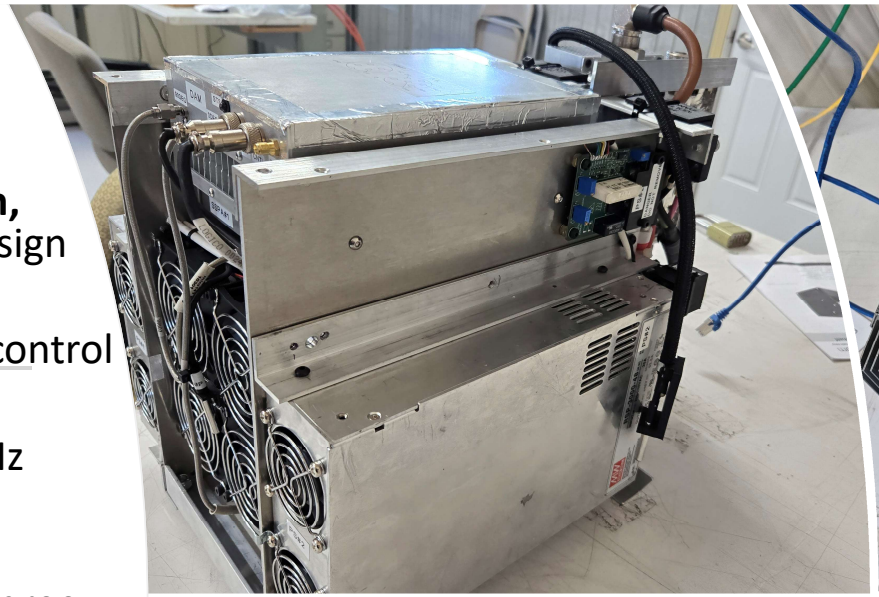
- 50 million miles (80.5 million km) round trip (during Earth-Venus inferior conjunction)
- 4.5 minutes round trip
- Path loss of 346 Db compared to 283 Db for the Moon
- We need to make up about 24Db of the link margin with improved transmit and better digital receiving methods
- Venus and Earth's orbital velocities and rotations create Doppler shift and spread
- A very accurate time base is required. University of Colorado, Boulder loaned us a Rubidium clock!
- Minimum sun separation of 10 degrees to avoid additional noise, so not exactly during the Earth-Venus inferior conjunction
- 1296 MHz (23cm band) was chosen because of the trade-off of availability of high-power amplifiers vs narrower beam width and gain in 13 cm band
- Modulation Schemes
  - Carrier only
  - Very Slow Morse CW
  - Modified Q65(C)-120 digital mode and other digital modes
  - Post Processing of recordings

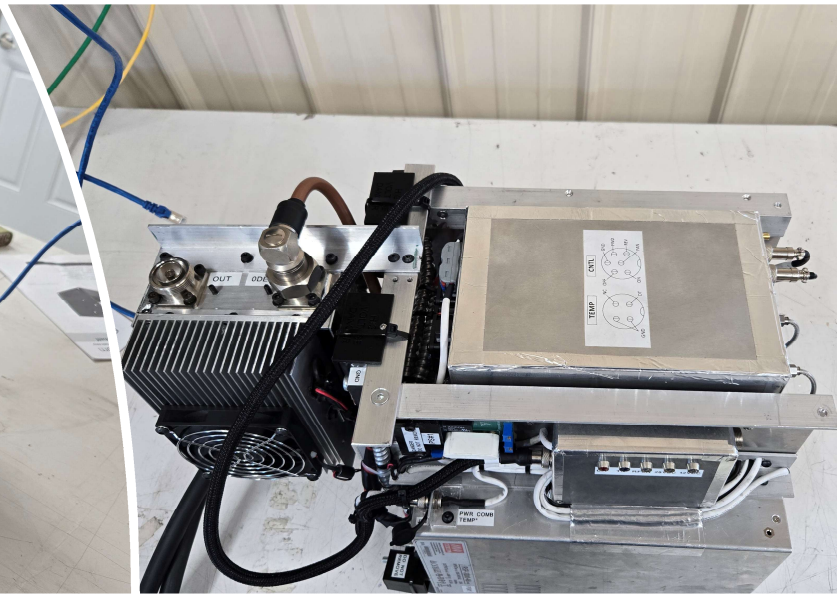
Earth-Venus-Earth (EVE), continued

- Not without precedent: Arecibo radar-mapped Venus at 13cm, and the 20M German Bochum Observatory had detected their own 13cm signal off the planet with their dish and a 6.5KW transmitter. But as far as we knew, no other amateur group had ever achieved communication by reflecting a signal off of Venus.
- The ultimate goal was to have an information exchange (QSO) with our own station and other earth stations via Venus. This would demonstrate that the DSES can overcome difficult conditions and develop new technologies and methods to further amateur radio and STEM goals.
- In August, 2024 a grant proposal was made to the Amateur Radio Digital Communications (ARDC) organization and was accepted. An EVE system was designed and built.
- DSES collaborated with the Astropeiler Stockert 25M Dish group in Germany, the 25M Dwingeloo Dish Group in the Netherlands, and the 18.3M Princeton University Camp Evans Infoage Museum group in Wall-Township, New Jersey to attempt this first.

EVE Transverter and Amplifier

- Built by **Alex Nerseasian, K6VHF** an aerospace design engineer
- Remote telemetry and control via Fiber Optic Ethernet
- 50MHz (6m) to 1296MHz (23cm) transverter
- 300W 1296MHz driver amplifier with +/- 90-degree phase shifter
- Dual 1296MHz 1kW Amplifiers
- 90-degree phase combiner
- Capable of 2kW output, limited to 1.5kW per FCC regulations.
- EIRP with 42.5dBi antenna gain is ~**21 Megawatts**





Installing EVE on the Dish

Climbing Harnesses Required while on the 32-foot (10m) maintenance tower.

Clockwise from top left:

- Raising EVE to the top of the maintenance tower.
- Dr. Dennis Akos, Instructor at University of Colorado, Boulder visits and gets to test his climbing skills
- Derek Darby and Roger Oakey worked on the feed antenna and installed the 80 LB (36kg) EVE transverter package in the Dish Hub


DAM
STS
90DEG
0DEG
PTT
DT
CNTL
J18
J19
J20
SSPA#1
-90DEG
+90DEG
#2

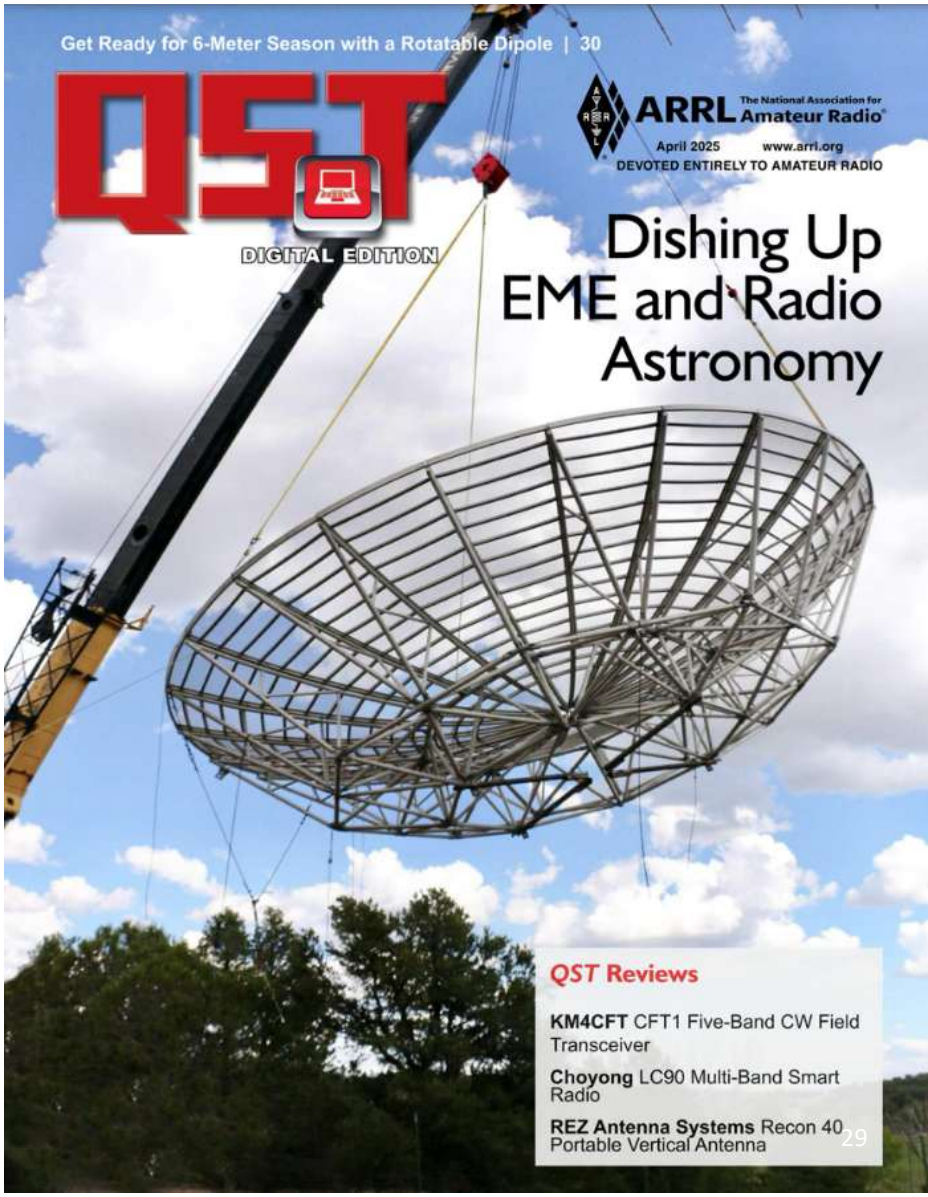
So, how'd EVE go?

- BLUF: We didn't succeed.
- On the Morning of March 22, 2025, the Earth-Venus-Earth "bounce" was attempted.
- Before Venus even rose for us, Dwingeloo with their 1kW variance transmitted a carrier and Stockert was able to receive it.
- Dwingeloo and Stockert now hold claim to the first successful amateur radio bounce off of Venus.
- We had a transmitter failure and they had a receive failure when we transmitted, so we don't know if they could have received our transmission or not.
- All is not lost: No actual information (communication / QSO) has been successfully bounced off of Venus, so those goals remain.
- Next Earth-Venus inferior conjunction in October, 2026

30-Foot Dish Rescue (June 23-26, 2024)

- Patti Clark, widow of Robert B Clark KØYW, in Ignacio, Colorado donated the 30-foot (9m) parabolic dish that was destined for the scrapyard unless DSES could disassemble and move it.
- A public funding process was undertaken in May, the "Save the 30-foot Parabolic Dish Antenna Project in Southwestern Colorado".
- A nine-person crew traveled to Ignacio on a four-day trip with three trailers to successfully rescue the 30-foot dish. A crane was rented and the crew worked in challenging temperature conditions to dismantle, transport, and document the dish for reassembly at Haswell.
- Now the DSES needs to raise the money to pour the concrete foundation and resurrect the dish.
- Our member, Elaine Hambly KØARR wrote the article that appears in the April, 2025 QST magazine.

http://www.arrl.org/files/file/QST/This%20Month%20in%20QST/2025/april%2025/0425%20Hambly%20Free.pdf



STEM Education and Outreach

- Annual open house, typically held in September
- Optical and radio astronomy presentations and demonstrations
- Judging and awards for Pikes Peak Regional Science and Engineering Fairs
- Publications on radio and radio astronomy
- Society of Amateur Radio Astronomers (SARA)
- Site trips and tours of the National Radio Observatories
- Website with all proceedings and articles open to the public http://dses.science/
- Mentorship of students
- Presentations to amateur radio and other civic clubs

Education & Outreach

PP Regional Science Fair, Xander Duval

Society of Amateur Radio Astronomers (SARA) western conference, Hans Gaensbauer

Las Animas High School Science Olympiad seminar

DSES Annual Open House (September)

Solar observing

Site tours

Dish awestruck

Meetings, Trips and Membership

- Engineering and Operations Zoom meeting every 2nd Monday of the month at 6:30PM MT
- Science Zoom meeting every 4th Monday of the month at 6:30PM MT
- Work trips are scheduled “as needed” – join the “DSES” group on groups.io to stay abreast of all information and trips
- Join the DSES for $50/year
- Can join by pay-pal on our site http://dses.science/

ARRL EME contest, weekend 4: 50 to 1296 MHz

DSES members invited November 7 - 9

November 7 - 8: 6:22pm until 10:25am
November 8 - 9: 7:29pm until 11:21am

SSB and CW operations will be attempted at 7pm and 10am the 7 - 8th and at 8pm and 11am on the 8 - 9th (at a minimum).

Contacts are not guaranteed of course, but at the very least you'll hear your voice echo off the moon!

Thank you for your time!
Join us at:
http://dses.science/

https://www.youtube.com/@DeepSpaceExplorationSociety

Questions?

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Paul Sobon / NOØT pauls@dses.science


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Raisins