

British Astronomical Association || Radio Astronomy Section ||

SARA's Telescope in a Box and improvements

PABLO LEWIN (WA6RSV)

**BRITISH ASTRONOMICAL ASSOCIATION || RADIO ASTRONOMY
SECTION ||2021**

A little bit about me:

Active Ham radio
Operator WA6RSV since
1976

I work all bands, all
modes including, CW, FT-
8,Q65 ,WSPR 24/7

Working towards getting
EME operations active

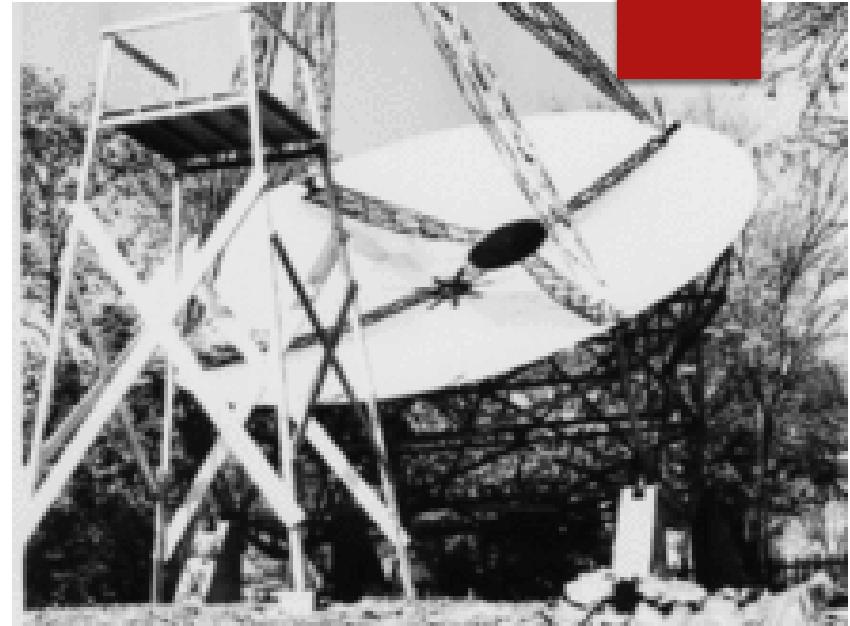
Active Citizen/Scientist
Astronomer member of
AAVSO,AAS,SARA and
NASA TESS Follow up
group 1. NASA Exoplanet
Watch, MPC U76

Own and operate private
research level backyard
observatory

Retired Airline Pilot

Briefly what's Radio Astronomy?

- ▶ 1) Radio astronomy is a subfield of astronomy that studies celestial objects at radio frequencies.
- ▶ 2) The first detection of radio waves from an astronomical object was in 1932, when Karl Jansky at Bell Telephone Laboratories observed radiation coming from the Milky Way.
- ▶ 3) Grote Reber W9GFZ (SK) (December 22, 1911 – December 20, 2002) was an American pioneer of radio astronomy, which combined his interests in amateur radio and amateur astronomy. He was instrumental in investigating and extending Karl Jansky's pioneering work and conducted the first sky survey in the radio frequencies. His 1937 radio antenna was the second ever to be used for astronomical purposes and the first parabolic reflecting antenna to be used as a radio telescope. For nearly a decade he was the world's only radio astronomer.



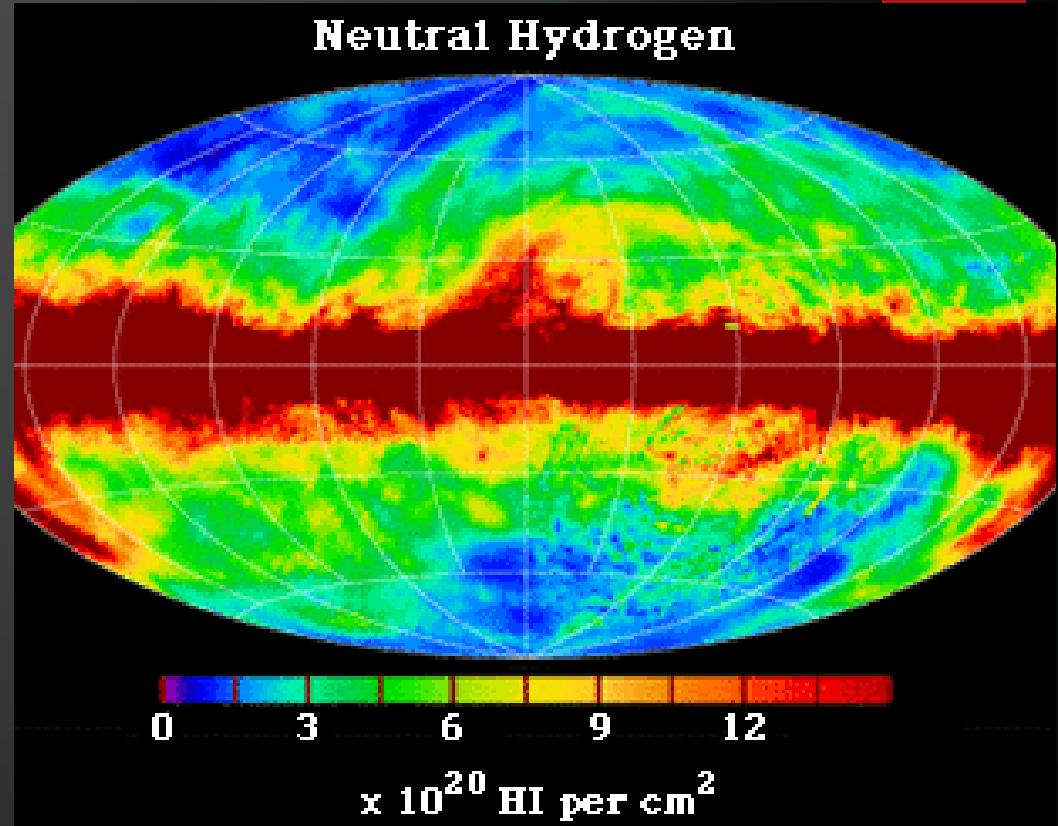
A Brief History of Radio Astronomy in UK

- ▶ The development of radar during the Second World War had two consequences for radio astronomy. Firstly, sources of radio interference which might confuse radar location had to be identified. Hey and his colleagues continued to improve the sensitivities of the receivers and discovered that the background radio emission from the Galaxy itself limited the sensitivity of the telescope system. At the end of hostilities, Hey and his colleagues began mapping the sky at 5m wavelength and in 1946 they discovered the first discrete source of radio emission, which lay in the constellation of Cygnus - the source became known as Cygnus A.
- ▶ At [Cambridge University](#), where ionospheric research had taken place during [World War II](#), [J.A. Ratcliffe](#) along with other members of the [Telecommunications Research Establishment](#) that had carried out wartime research into [radar](#), created a radio physics group at the university where radio wave emissions from the Sun were observed and studied. This early research soon branched out into the observation of other celestial radio sources and interferometry techniques were pioneered to isolate the angular source of the detected emissions. [Martin Ryle](#) and [Antony Hewish](#) at the [Cavendish Astrophysics Group](#) developed the technique of Earth-rotation [aperture synthesis](#). The radio astronomy group in Cambridge went on to found the [Mullard Radio Astronomy Observatory](#) near Cambridge in the 1950s. During the late 1960s and early 1970s, as computers (such as the [Titan](#)) became capable of handling the computationally intensive [Fourier transform](#) inversions required, they used aperture synthesis to create a 'One-Mile' and later a '5 km' effective aperture using the One-Mile and Ryle telescopes, respectively. They used the [Cambridge Interferometer](#) to map the radio sky, producing the [Second](#) (2C) and [Third](#) (3C) Cambridge Catalogues of Radio Sources

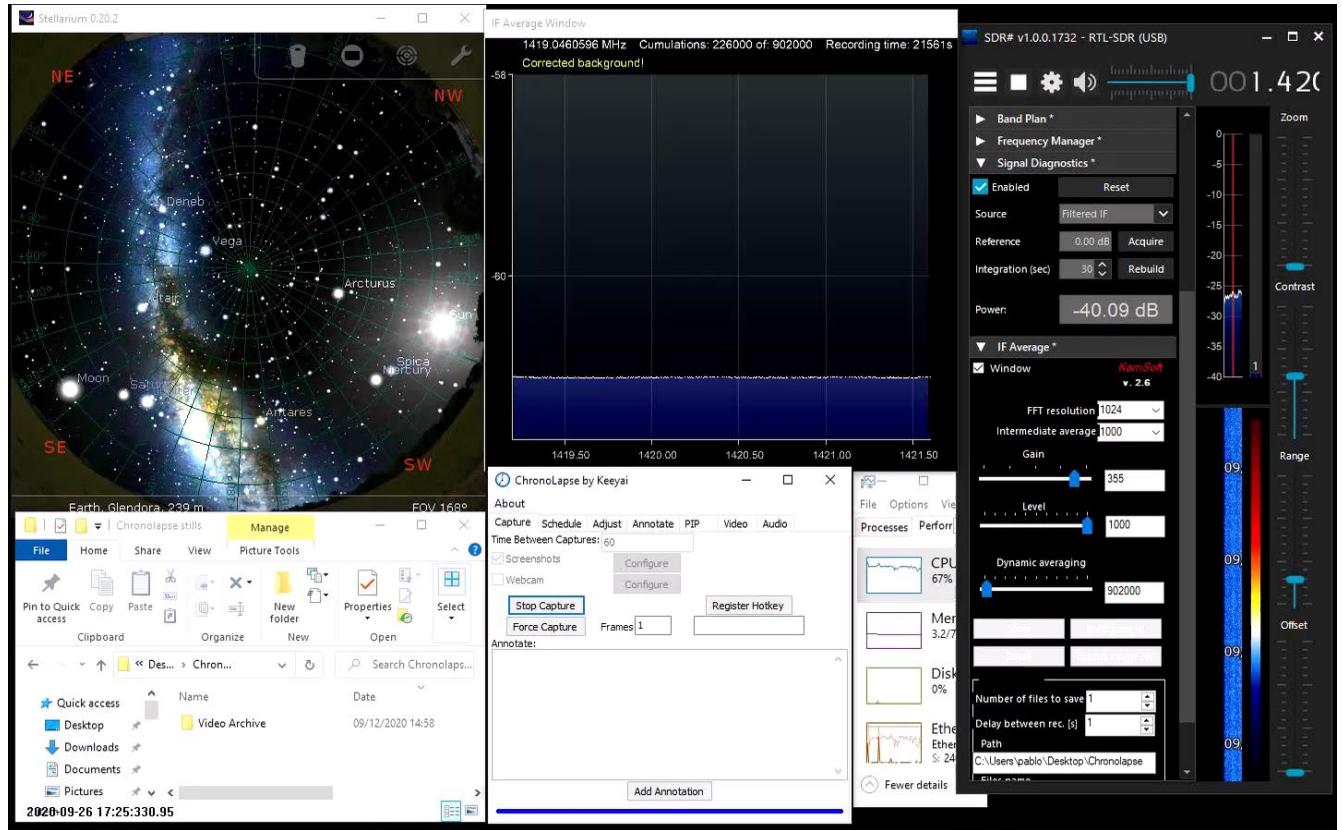


Just one more piece of theory then I'll get on with it, I promise!!

- ▶ If you don't know what the hydrogen line is, Here's a brief explanation. Hydrogen atoms randomly emit photons at a wavelength of 21cm (1420.4058 MHz). Normally a single hydrogen atom will only very rarely emit a photon, but the galaxy and even empty space is filled with many hydrogen atoms, so the average effect is an observable RF power spike at \sim 1420.4058 MHz. By pointing a radio telescope at the night sky and averaging the RF power over time, a power spike indicating the hydrogen line can be observed in a frequency spectrum plot. This can be used for some interesting experiments, for example you could measure the size and shape of our galaxy. Thicker areas of the galaxy will have more hydrogen and thus a larger spike, whereas the spike will be significantly smaller when pointing at empty space. You can also measure the rotational speed of our galaxy by noting the frequency doppler shift..



Neutral Hydrogen ($\lambda=21\text{ cm}$), radio map of the Milky Way. From Dickey and Lockman 1990.



Enough intros and theory show me what this \$300 system do for me!
 If a picture is worth a thousand words, then a video?..

Basic Scope in a Box

- ▶ Based on the RTL-SDR CHEAP AND EASY HYDROGEN LINE RADIO ASTRONOMY WITH AN RTL-SDR, WIFI PARABOLIC GRID DISH, LNA AND SDRSHARP ARTICLE

OFF THE SHELF 2.4GHZ DISH

OFF THE SHELF SDR-RTL (BIAS T)

OFF THE SHELF LNA (WITH 50 OHM)



DM

ware defined radio news and projects. Also featuring Airspy, H

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/ HYDROGEN LINE RADIO ASTRONOMY WITH AN RTL-SDR, WIFI PARABOLIC GRID DISH, LNA AND SDRSHARP ARTICLE



Nooelec SAWbird+
Cascaded Ultra-Low
Hydrogen Line (21cm)
Frequency

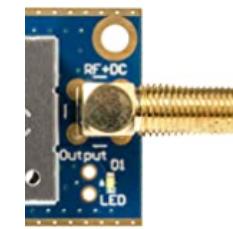
Brand: NooElec

★★★★★ 8 ratings

Best Seller

Price: \$37.95 FREE On

Get \$10 bonus w



OK, to build this what do I need to buy and where are the plans??

RTL-SDR.COM

RTL-SDR (RTL2832U) and software defined radio news and projects. Also featuring Airspy, HackRF, FCD, SDRplay and more.

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JANUARY 31, 2020

CHEAP AND EASY HYDROGEN LINE RADIO ASTRONOMY WITH AN RTL-SDR, WIFI PARABOLIC GRID DISH, LNA AND SDRSHARP



RTL-SDR Blog R820T2 RTL2832U 1PPM TCXO SMA Software Defined Radio (Dongle Only)

Brand: RTL-SDR Blog

★★★★★ 1,305 ratings | 128 answered questions

11 Price Changes

Price: \$29.95 & FREE Returns

Save up to 21% with business pricing. Sign up for free Amazon Business account

- Includes 1x RTL-SDR Blog brand R820T2 RTL2832U 1PPM TCXO HF Bias Tee SMA Dongle (V3) (Dongle Only)
- Great for many applications including general radio, air traffic control, public safety radio, ADSB, ACARS, trunked radio, P25 digital voice, POCSAG, weather balloons, APRS, NOAA APT weather satellites, radio astronomy, meteor scatter monitoring, DAB, classroom learning, or for use as a low cost parapander with a traditional ham radio.
- Several improvements over other brands including use of the R820T2 tuner, improved component tolerances, a 1 PPM temperature compensated oscillator (TCXO), SMA F connector, aluminum shielded case with thermal pad for passive cooling, activatable bias tee circuit and a much improved antenna set.
- Can tune from 500 kHz to 1.7 GHz and has up to 3.2 MHz of instantaneous bandwidth (2.4 MHz stable). (HF reception below 24 MHz in direct sampling mode with reduced performance). Please note RTL-SDR dongles are RX only.

Nooelec SAWbird+ H1 Barebones - Premium Saw Filter Cascaded Ultra-Low Noise Amplifier (LNA) Module for Hydrogen Line (21cm) Applications. 1420MHz Center Frequency

Brand: NooElec
★★★★★ 8 ratings

Price: \$37.95 FREE One-Day & FREE Returns

Get \$10 bonus when you reload \$100 or more to your gift card balance.

Dish Tripod with Level and Compass, 3 Feet Tall

Brand: Unbranded
★★★★★ 82 ratings | 9 answered questions

2 Price Changes

Price: \$44.99 & FREE Returns

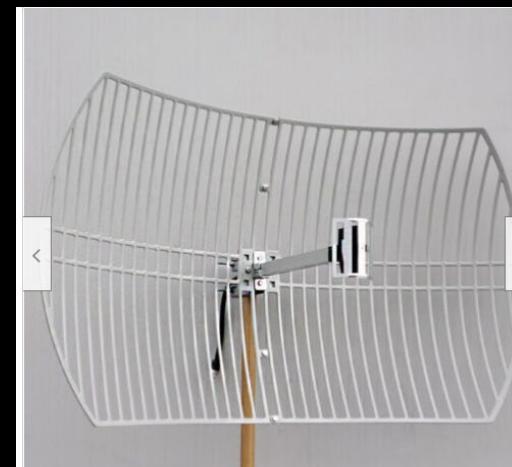
Get 5% back (\$2.24) in rewards on the amount charged to your Amazon Prime Rewards Visa Signature Card.

- Portable design for temporary dish mounting (Not for RV's)
- Convenient port & go design for use and can be easily removed
- Works with most parabolic dish or standard 18-inch satellite dishes or most dish separates
- Bubble Level & Compass for quick dish calibration (Not included)
- Adjustable height from 3' to 3.5' tall
- 3' tall | 1.50" OD mast included

Compare with similar items

Dish Clamp Power Strip, Desktop Power Outlet Clamp Mount with 2 Outlets and 2 USB Ports

★★★★★ 666 reviews



2.4GHz 802.11bgn 24dBi WiFi Parabolic Grid Antenna N Female Mounting Kits

★★★★★ 10 product ratings

Condition: New

Bulk savings: Buy 1 \$85.99/ea | Buy 2 \$81.69/ea

Quantity: 1 2 or more for \$81.69/ea

More than 10 available
[346 sold](#) / See feedback

Price: US \$85.99/ea

[Buy It Now](#)

[Add to cart](#)

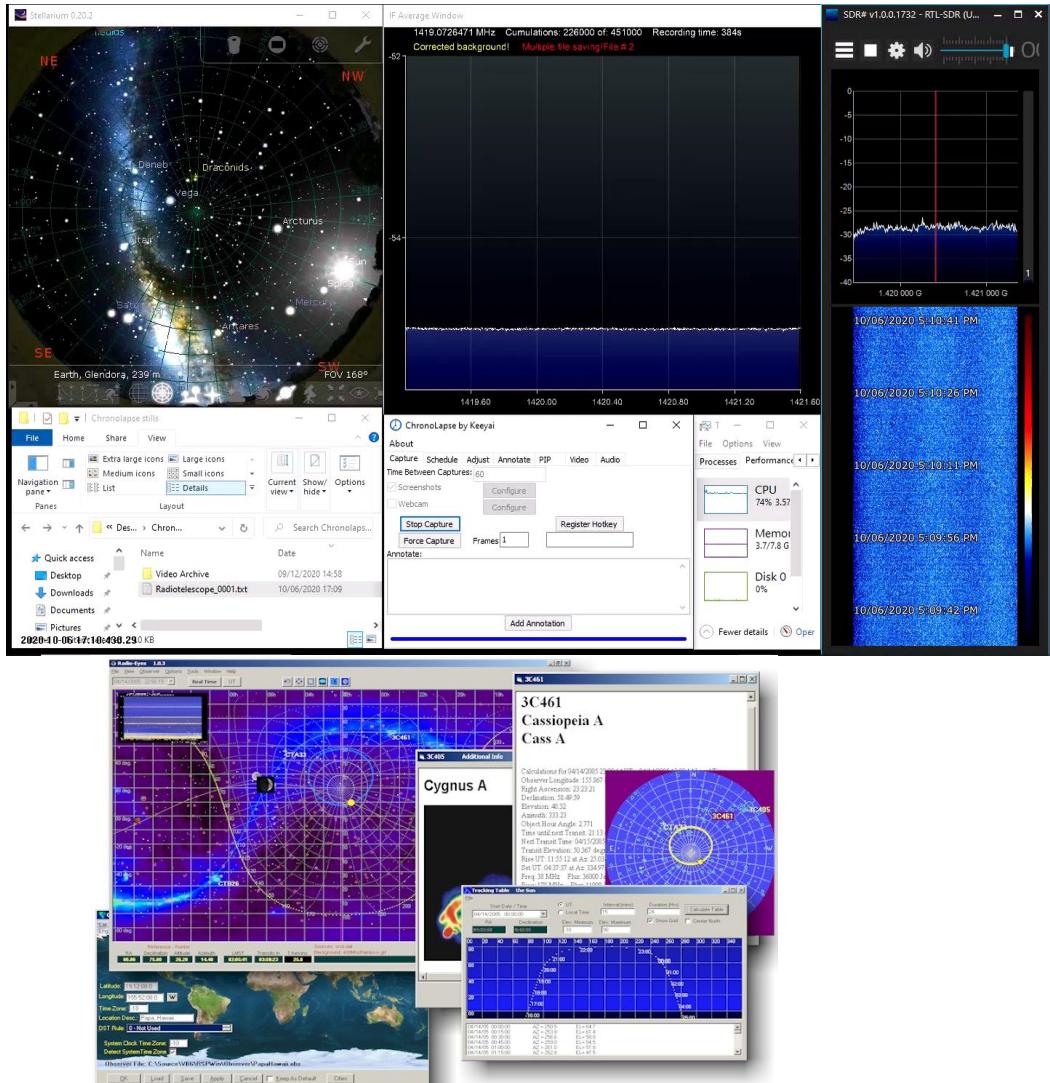
[Add to Watchlist](#)

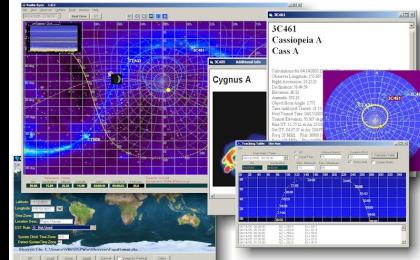
Software for basic “Scope in a Box”

- 1) Stellarium (free) is a free and open-source planetarium, licensed under the terms of the GNU General
- 2) SDR Sharp (free) In order to detect the hydrogen line we need to use software capable of integrating/averaging many FFT samples over time. Averaging the samples reduces the SDRs quantization noise, allowing the weak hydrogen line peak to be seen. Because the galaxy is moving fairly slowly in the sky, we can safely average for 5-10 minutes at a time.
- 3) Chronolapse (free) for recording the event
- 4) Radio Eyes (OPTIONAL AND NOT FREE). The Best!

Radio Eyes is not just a typical sky viewer that has mappings for radio objects. It is a tool to help you plan and execute your radio observations.

- ▶ correction technique (50 ohm load or simply correct background with no Hydrogen signal)





Nooelec Lana Barebones - Ultra Low Noise Module for RF & Software Defined Radios and Linear 20MHz-4000MHz Frequency Synthesizer & USB Power Options

Brand: NooElec
★★★★★ 67 ratings

Best Seller

Price: \$19.95 **prime** & FREE Returns

Get \$10 bonus when you reload \$100 or more

IMPROVEMENTS TO THE SCOPE IN A BOX

Heavy Duty 30" Linear Actuator Polarity Switch Inch Stroke 12v 200LBS Max Lift

Condition: New
Quantity: 1 Last one 23 sold / See feedback

Price: US \$75.95

Buy another Add to cart Add to Watchlist

100% buyer satisfaction 23 sold Free shipping and returns

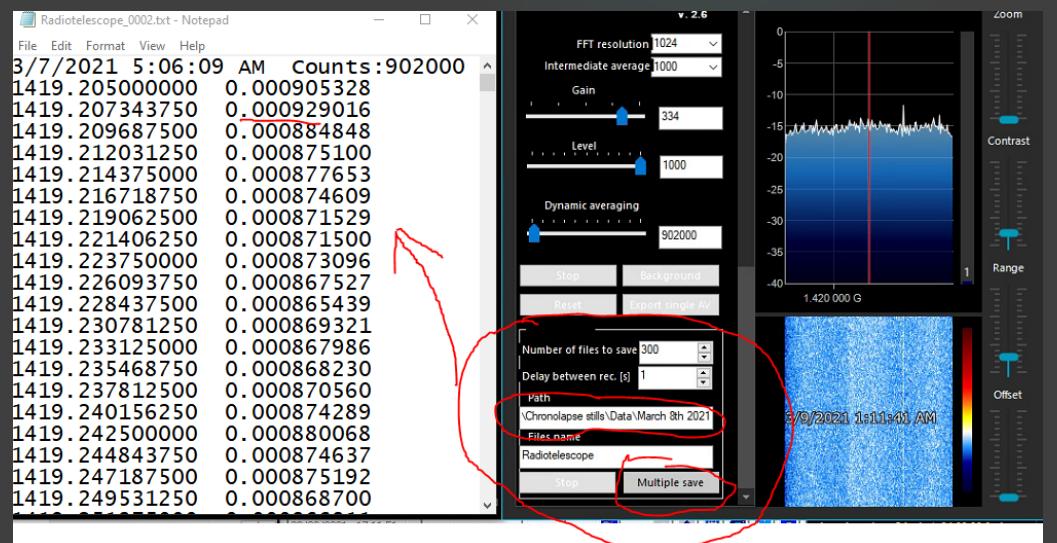
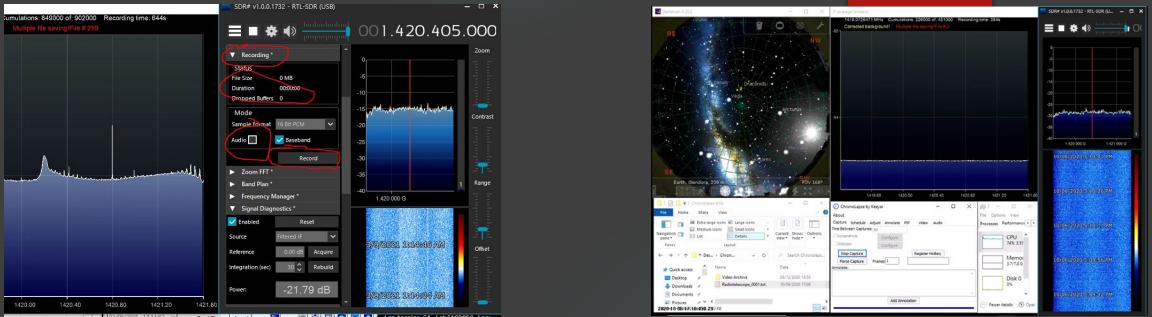
Shipping: FREE Expedited Shipping | See details
Item location: Sarasota, Florida, United States
Ships to: United States and many other countries | See details

Delivery: Estimated between Mon. Feb. 8 and Tue. Feb. 9
Payments: PayPal G Pay VISA MasterCard Diners EBCard
PayPal CREDIT
Special financing available. | See terms and apply now
Earn up to 6x points when you use your eBay Mastercard®. Learn more
Returns: Free 30 day returns | See details

- ▶ Mesh (1/4 inch)
- ▶ Second LNA (Wideband)
- ▶ Radio Eyes software
- ▶ Elevation Actuator

Results that can be expected with the Scope in a Box

- ▶ Galactic H1 Line detection.
- ▶ Visual display
- ▶ Movie of results
- ▶ Raw Data collection
- ▶ Audio Collection



Computer strategies

- ▶ Types of computers
- ▶ No WiFi
- ▶ Improving Shielding
- ▶ USB Switch for LNA 50 ohm built in switch



VGA Dummy Plug,Headless Ghost, Headless-1920x1080@60hz

Brand: FUERAN

★★★★★ 65 ratings

Checking Prices...

Price: \$8.54 & FREE Returns

Get \$10 bonus when you reload \$100 or more

- Solving problems such as stop working for no reason when using Windows, OSX, Linux and just about everything else Ultra HD
- design Supporting Plug and Play, Hot Plug
- Requiring no driving forces, supporting all systems
- Allows for high resolution, GPU accelerated remote desktop
- Acts as a dummy plug for use with GPU tasks such as crysis

THROUGH EDID PLEASE ENTER THE STORE TO PURCHASE



Lenovo ThinkCentre M92p Tiny Mini Business Desktop Computer, Intel Core i5-3470T up to 3.6Ghz, 8GB RAM, 500GB HDD, Intel HD Graphics, VGA, USB 3.0, Windows 10 Professional (Renewed)

Visit the Amazon Renewed Store

★★★★★ 201 ratings | 45 answered questions

Best Seller

Price: \$162.99

Pay \$27.17/month for 6 months, interest-free with your Amazon Prime Rewards Visa Card

Product works and looks like new. Backed by the 90-day Amazon Renewed Guarantee.

- This pre-owned product has been professionally inspected, tested and cleaned by Amazon-qualified suppliers.
- There will be no visible cosmetic imperfections when held at an arm's length.
- Products with batteries will exceed 80% capacity relative to new.
- Accessories may not be original, but will be compatible and fully functional. Product may come in generic box.

This product is eligible for a replacement or refund within 90 days of receipt if you are not satisfied.

SMAKN LCUS-1 type USB intelligent control switch

Brand: SMAKN

★★★★★ 25 ratings | 29 answers

Amazon's Choice for USB Cables by SMAKN

Best Seller

Price: \$15.60 FREE One-Day & Prime Shipping

Get \$10 bonus when you reload \$100 or more on balance.

May be available at a lower price from other sellers without free Prime shipping.

- USB intelligent control switch.
- Onboard high-performance microcontroller.
- Onboard 5V, 10A / 250VAC, 10A / 30VDC continuous pull 100,000 times.
- Relay modules with overcurrent protection.



A Larger Dish

- ▶ Where to get cheap/free Dishes Offerup,Craigslist,Freecycle, Nextdoor
- ▶ Building a feedhorn
- ▶ Soldering for the first time



OfferUp

OfferUp is the simplest way to buy and sell locally. Get the free app.

Get on Google Play Download on the App Store

★★★★★ (325) Write

Cast Aluminum body - C

Auto start/stop ignition feature

Pressure regulated for consistent flame

See More Details

\$47.97

Save up to \$100 on your next home improvement project. Apply for a Home Depot credit card today!

How to Get It

Buy in Store Limited stock at Covina Check Nearby Store

3 available for delivery to 91 How It Works

• \$25 C-band 10 foot satellite dish with LNB. Dish is in very good condition.

Tustin, CA Local pickup (29 miles away)

Posted 1 year ago in Electronics

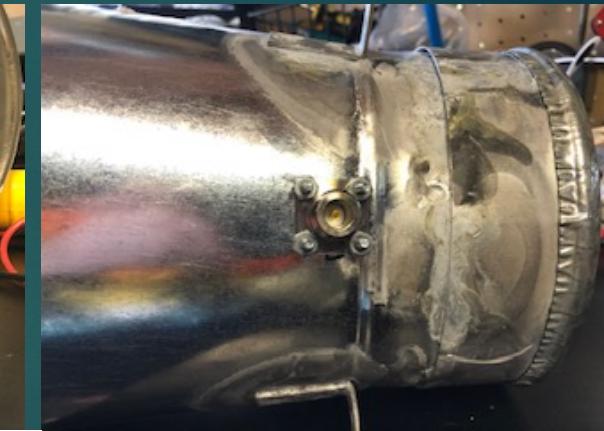
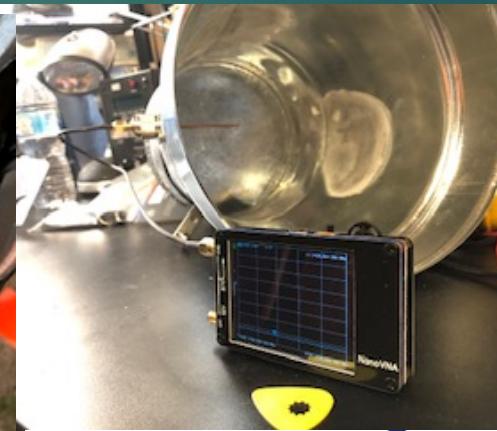
Used (normal wear)

Hasn't been used in many years. The dish itself is in very good condition. I have no idea whether or not the LNB or positioner are working. This first person with \$25 gets it.

Bob

Make offer Ask

Save Share



\$6.98

IMPERIAL 5 in Dia Galvanized Steel Round End Cap Item #3185 Model #KU-LC111-A

Used to terminate a round pipe run in a ventilation system

Crimped cap can be installed at end of round pipe with one screw

Galvanized steel construction

Add to Cart Buy This Now

Free Store Pickup 6 Available at 11 Locations - Apple 151 Bay 6

Delivery Available



BULK SAVINGS

\$9.58

10% OFF BULK NanoVNA-H Vector Network Analyzer

IMPERIAL 5-in dia Item #36409 Model #

Used to reduce the

Can also be used to

Galvanized steel construction

Add to Cart Buy It Now

Free Store Pickup 5 Available at 11 Locations - San Jose 151 Bay 6

Delivery Available

1 viewed per hour ★★★★☆ 24 product ratings

NanoVNA-H 10KHz-1.5GHz Vector Antenna Network Analyzer VHF UHF UV HF VNA + Shell

Price: US \$52.68

Condition: New

Quantity: 1

It's sold / See feedback

Best Offer:

Make Offer

Add to Watchlist

Buy It Now

Add to cart

Delivery Available

Support TDR Function

Support type-c type-c Line

2.8 inch TFT Touch

SWR: < 1.1

10KHz - 1.5GHz

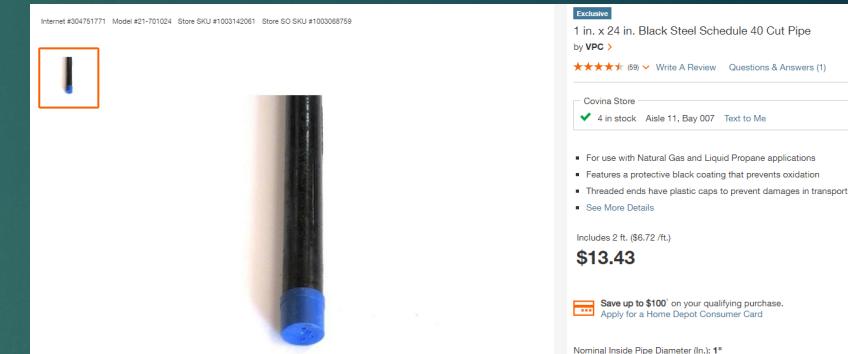
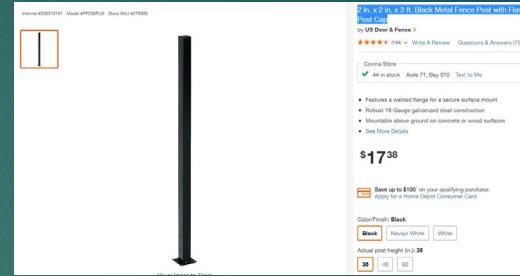
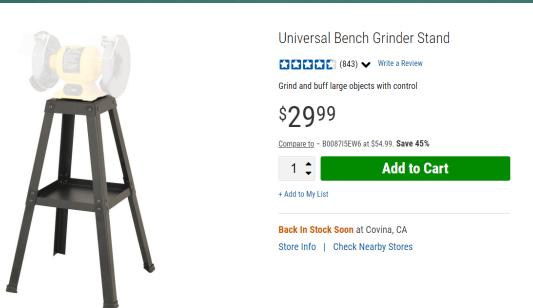
100% buyer satisfaction

114 sold

More than 95% sold

An Inexpensive, Sturdy Alt/Az mount

- ▶ The front wheel axle
- ▶ The Universal Bench grinder stand
- ▶ Fence Posts
- ▶ Black steels pipes
- ▶ Ubolts, floor flange and steel nipples



The Mount assembly and Elevation motor

- ▶ The Linear Actuator
- ▶ Elevation simple remote control
- ▶ Quikrete and Electric auger



Heavy Duty 30" Linear Actuator Polarity Switch Inch Stroke 12v 200LBS Max Lift

Condition: New
Quantity: 1 Last one
23 sold / See feedback

Price: US \$75.95

Add another Add to cart Add to Watchlist

100% buyer satisfaction 23 sold Free shipping and returns

Shipping: FREE Expedited Shipping | See details
Item location: Sarasota, Florida, United States
Ship to: United States and many other countries | See details

Deliver: Estimated between Mon, Feb. 8 and Tue, Feb. 9
Payments: PayPal G Pay VISA MasterCard American Express

Special financing available | See terms and apply now

This product listing shows a heavy-duty linear actuator for sale. It includes details about the product, price, shipping, and payment options.

Product: Heavy Duty 30" Linear Actuator Polarity Switch Inch Stroke 12v 200LBS Max Lift

Condition: New

Quantity: 1

Price: US \$75.95

Shipping: FREE Expedited Shipping | See details

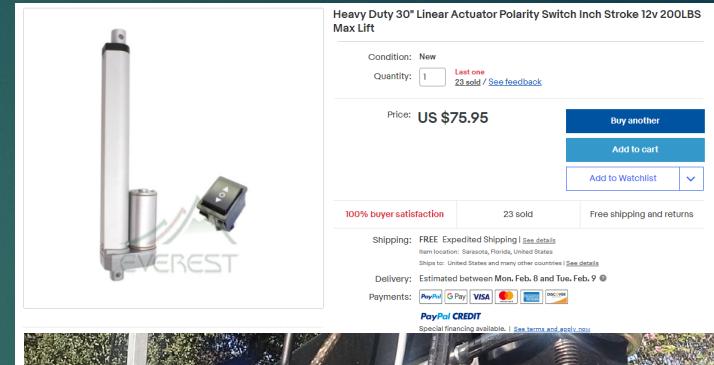
Item location: Sarasota, Florida, United States

Ship to: United States and many other countries | See details

Deliver: Estimated between Mon, Feb. 8 and Tue, Feb. 9

Payments: PayPal G Pay VISA MasterCard American Express

Special financing available | See terms and apply now



The mount assembly and the Azimuth motor

- The sprockets
- The motor
- The chain



L-FASTER 9 Tooth Sprocket for Bike Motor
MY1016Z Unitemotor MY1018 Original 9T
Sprocket Scooter Engine Sprocket for 410

Brand: L-FASTER
★★★★★ 58 ratings
Amazon's Choice

Best Deal
Price: \$7.99 & FREE Returns

Get \$10 bonus when you reload your gift card balance with \$100 or more.



Bringsmart 12V 3rpm DC Worm Gear Motor
25kg.cm High Torque Mini Turbine Worm
Reducer Motor Self-locking Micro Gear Motor
Reversible (JGY-370 12V 3rpm)

Brand: Bringsmart
★★★★★ 93 ratings

Best Deal
Price: \$14.99 & FREE Returns

Your cost could be \$4.99. Eligible customers get a \$10 bonus when reloading \$100.

Size: JGY-370 12V 3rpm
12V 3rpm | 12V 18rpm | 12V 23rpm | 12V 30pm | 12V 40pm
12V 66pm | 12V 90pm | 12V 160pm | 12V 210pm
JGY-370 12V 3rpm | JGY-370 12V 10pm | Bracket



JRL Wheel Sprocket 36T 36 Tooth Motorized
Gas Cycle Bicycle 50cc 60cc 80cc

Brand: JRL
★★★★★ 104 ratings | 12 answered questions

Best Deal

Price: \$12.30 & FREE Returns

Your cost could be \$2.30. Eligible customers get a \$10 bonus when reloading \$100.
May be available at a lower price from other sellers, potentially without free Prime shipping.

- Fit 49cc 50cc 66cc 80cc Motorized Bicycle Bike Moped
- Package Include: 1x sprocket
- USE FOR Rear Sprocket Mount: Mounting Pads Kits/ 9 Hole Sprocket Mount Kit Use for 49cc 50cc 66cc 80cc Sprocket USE For Rear Wheel Disk Brake Bell Bearing
- Purchase With Confidence: Buy our Motorparts Product knowing it's a perfect fit, excellent quality, built to last, and most importantly we stand behind our products.

[See more product details](#)

Compare with similar items

New (2) from \$1.99 & **FREE Shipping**

[Report incorrect product information.](#)



420 Motorcycle Chain - 420 Standard
Roller Chain for 110cc 125cc Go kart
Dirt Pit Bike ATV Quad Scooter Mini
Bike, Total 132 Links, Free Chain Breaker
Included

Brand: AOIT
★★★★★ 39 ratings | 9 answered questions

Best Deal

Price: \$18.99 & FREE Returns

Save 5% on 2 select item(s). Shop items

Get \$10 bonus when you reload your gift card balance with \$100 or more.

- Made of alloy steel, this 420 roller chain is in premium quality, heavy duty, strong and durable
- Fit for 110cc 125cc go cart, dirt bike, pit bike, mini bike, scooter, ATV quad etc
- Chain total length 132 links, long enough for your use
- Come with a master link and chain breaker, cut the chain to required length and reconnect
- Package including 1pcs roller chain with a master link and 1pcs chain breaker

[See more product details](#)

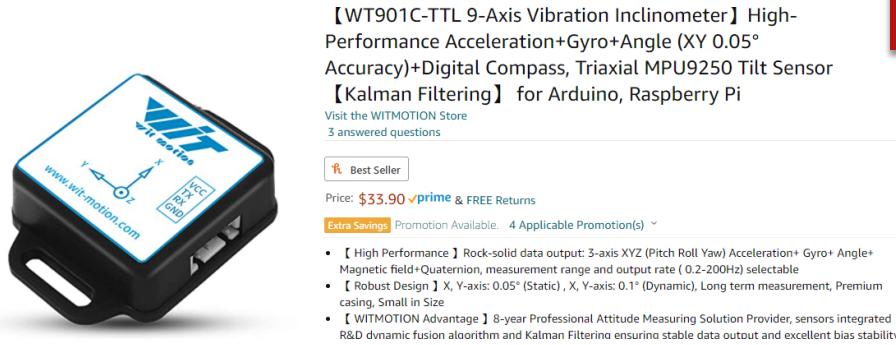
Compare with similar items

[Report incorrect product information.](#)



Mount Computer Control and remote position feedback

- ▶ Simple Motor controllers
- ▶ Witmotion Sensor with cable
- ▶ Live demonstration of Radio Telescope Operation



【WT901C-TTL 9-Axis Vibration Inclinometer】 High-Performance Acceleration+Gyro+Angle (XY 0.05° Accuracy)+Digital Compass, Triaxial MPU9250 Tilt Sensor

【Kalman Filtering】 for Arduino, Raspberry Pi

Visit the WITMOTION Store

3 answered questions

Best Seller

Price: \$33.90 & FREE Returns

Extra Savings! Promotion Available. 4 Applicable Promotion(s) ▾

- 【 High Performance 】 Rock-solid data output: 3-axis XYZ (Pitch Roll Yaw) Acceleration+ Gyro+ Angle+ Magnetic field+Quaternion, measurement range and output rate (0.2-200Hz) selectable
- 【 Robust Design 】 X, Y-axis: 0.05° (Static) , X, Y-axis: 0.1° (Dynamic), Long term measurement, Premium casing, Small in Size
- 【 WITMOTION Advantage 】 8-year Professional Attitude Measuring Solution Provider, sensors integrated R&D dynamic fusion algorithm and Kalman Filtering ensuring stable data output and excellent bias stability.

returns ▾

FREE delivery: Saturday, March 13
Order within 2 hrs and 28 mins
[Details](#)

Only 19 left in stock - order soon.

Qty: 1 ▾

Add to Cart

Buy Now

Secure transaction

Ships from Amazon

Motion Control Modules » Brushed DC Motor Controllers » Pololu Simple Motor Controllers » **Pololu Simple Motor Controller 18v7 (Fully Assembled)**



Pololu item #: 1372

31 in stock

Brand: [Pololu](#)

Status: Not Recommended for New Design

RoHS3

Price break Unit price (US\$)

1	41.95
5	38.59
25	35.51

Quantity:

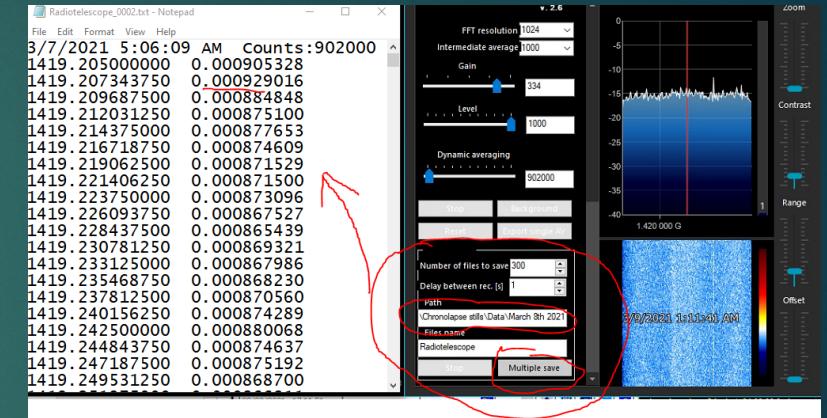
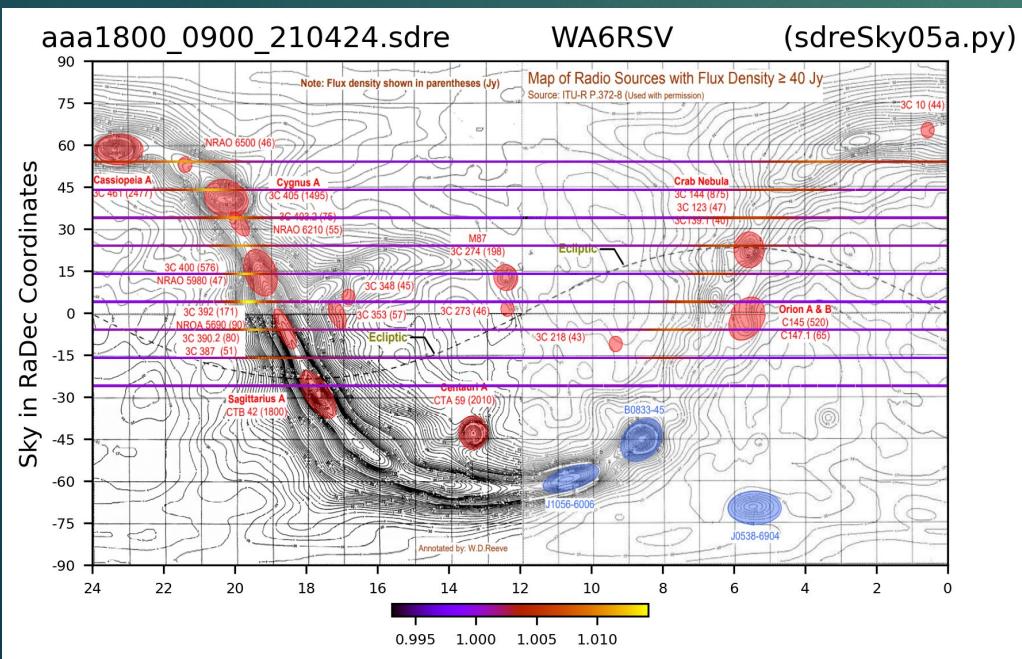
Add to cart

[backorders allowed](#)

Add to wish list

Possible Science applications IF Average

- Spectra: A spectrum is simply a chart or a graph that shows the intensity of light being emitted over a range of energies. ... Spectra can be produced for any energy of light, from low-energy radio waves to very high-energy gamma rays.



The sdrRA set of programs reveal information in the radio spectrum data files created by the popular SDR# Software Defined Radio program and an "IF Average Plugin", SARA member Ted Cline NORQV

Society of amateur Radio Astronomers (SARA)

 radio-astronomy.org

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SCOPE IN A BOX



REQUIRED FOR AMAZON SHIPPING
(Required)

\$295.00

0 [Add to Basket](#)

[Product Information](#) [Specification](#)

A ready made kit of parts and software to detect the Hydrogen line are now available through SARA.

The original design was from RTL-SDR.

<https://www rtl-sdr com/cheap-and-easy-hydrogen-line-radio-astronomy-with...>

We had three different SARA members build the kit and refine the software.

When you order the kit, the parts will be drop shipped from Amazon. This saves about \$70 in shipping costs.

You will also receive an email with a Dropbox download that will contain complete installation instructions and software.

Unfortunately sales are currently limited to addresses in the USA.

 **Society of Amateur Radio Astronomers**

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The Society of Amateur Radio Astronomers (SARA) Mission Statement

It shall be the Mission of the Society of Amateur Radio Astronomers (SARA) to:

- Facilitate the flow of information pertinent to the field of Radio Astronomy among our members.
- Promote members to mentor newcomers to our hobby, and share the excitement of radio astronomy with other interested persons and organizations.
- Promote individual and multi station observing programs.
- Encourage programs that enhance the technical abilities of our members to monitor cosmic radio signals, as well as to share and analyze such signals.
- Encourage educational programs within SARA and also educational outreach initiatives thru student and teacher grants for radio astronomy projects.
- The Society of Amateur Radio Astronomers, Inc. is a membership supported, non-profit [501(c) (3)], educational and scientific corporation.

What is The Society of Amateur Radio Astronomers (SARA)?

The Society of Amateur Radio Astronomers (SARA) is an international society of dedicated enthusiasts who teach, learn, trade technical information, and do their own observations of the radio sky.

This organization is a scientific, non-profit group founded for the sole purpose of supporting amateur radio astronomy. SARA was organized in 1981, and today has hundreds of members worldwide.

The group consists of optical astronomers, ham radio operators, engineers, teachers and non-technical persons. Many of our members are new to the field, and membership is extended to all who have an interest in radio astronomy.

Donate now to help SARA promote radio astronomy to students and teachers worldwide.



Join SARA!

SARA Annual Conference

- Conference info
- Keynote Speaker
- Paper Abstracts
- Conference registration

Articles on web

- York College students building local astronomers new, larger eye on the cosmos



Q&A

- ▶ Thank you for watching!
- ▶ Thank you Paul Hearn and the British Astronomical Association.
- ▶ Go ahead, ask any questions you want, I'm still not going to get paid and if I don't know the answer, I'll either research it or make it up or both!

- ▶ My contacts are
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