TAOSON SIGNAL

Issue No. 6 February, 2009

--

.. ..
- /.-/ ---/ …/ ---/ -. /…/ ../ --./ -./ .-/ .-..

…
….

TAOSON Director-- David Fields N4HBO
Newsletter Editor --Bill Seymour KM4YL

Table of Contents

Section	Title	Page Numbers
I.	Welcome	2
II.	Meetings	2-3
III.	The TAOSON Signal	3
IV.	Research Site Locations and Capabilities	3-4
V.	Basic Research Activities at Tamke-Allan Observatory	5-6
VI.	TAOSON Projects	7-8
VII.	Reports from The Sites	8-12
VIII.	The Basics	12-14
IX.	Notable Quote	14
X.	Links to Amateur Radio Astronomy Resources	14-15
XI.	A Professional-Amateur Dialogue	15-17

I. Welcome

Welcome to the **Tamke-Allan Observatory Solar Observation Network. TAOSON** was conceived in 2007 and operated for its first year as a student group at TAO with members Tyler Moore, Heather Fries and David Fields. In 2008 we opened up the group to the larger local amateur radio astronomy community.

The primary purpose of TAOSON is to keep local radio astronomers in touch and help coordinate their activities as they maintain their radio astronomy research sites. To this end we maintain a server for storing and sharing data, schedule meetings each month, and assist each other when needed. Most members support the Society of Amateur Radio Astronomers (see www.radio-astronomy.org).

TAOSON participates in the TAO Academic Associates of colleges and universities where members share research and scientific goals. This is both science and a humanistic endeavor that encourages cultural exchange. TAOSON also helps advise the TAO Space Explorer Groups with a common goal of developing capable and motivated human beings that will serve the community and become future scientists and contributors to a better world.

Membership is free if you're actively doing radio astronomy. Otherwise, membership is still free and you are invited to help with our projects.

II. Meetings

TAOSON

Meetings will be called as the need arises.

Meeting format will usually include a brief tutorial on a radio astronomy topic of interest, a work session on some chosen task or topic, a meal or refreshments, and a brainstorming session about projects. Our next meeting is at TAO on March 15 at 1500 h.

Area Optical Astronomy Groups

Oak Ridge Isochronous Observation Network (Orion) meets at 7:00 P.M. on the first Wednesday of each month The Club Room, Oak Ridge Civic Center. See www.roanestate.edu/obs and www.orioninc.org

Barnard Astronomical Society (BAS) meets at 7:00 P.M. on the second Thursday of each month at the UT Chattanooga Clarence Jones Observatory. See BAS@chattanooga.net.

Upcoming Events

TAOSON meets at TAO on March 15 at 1500 h.

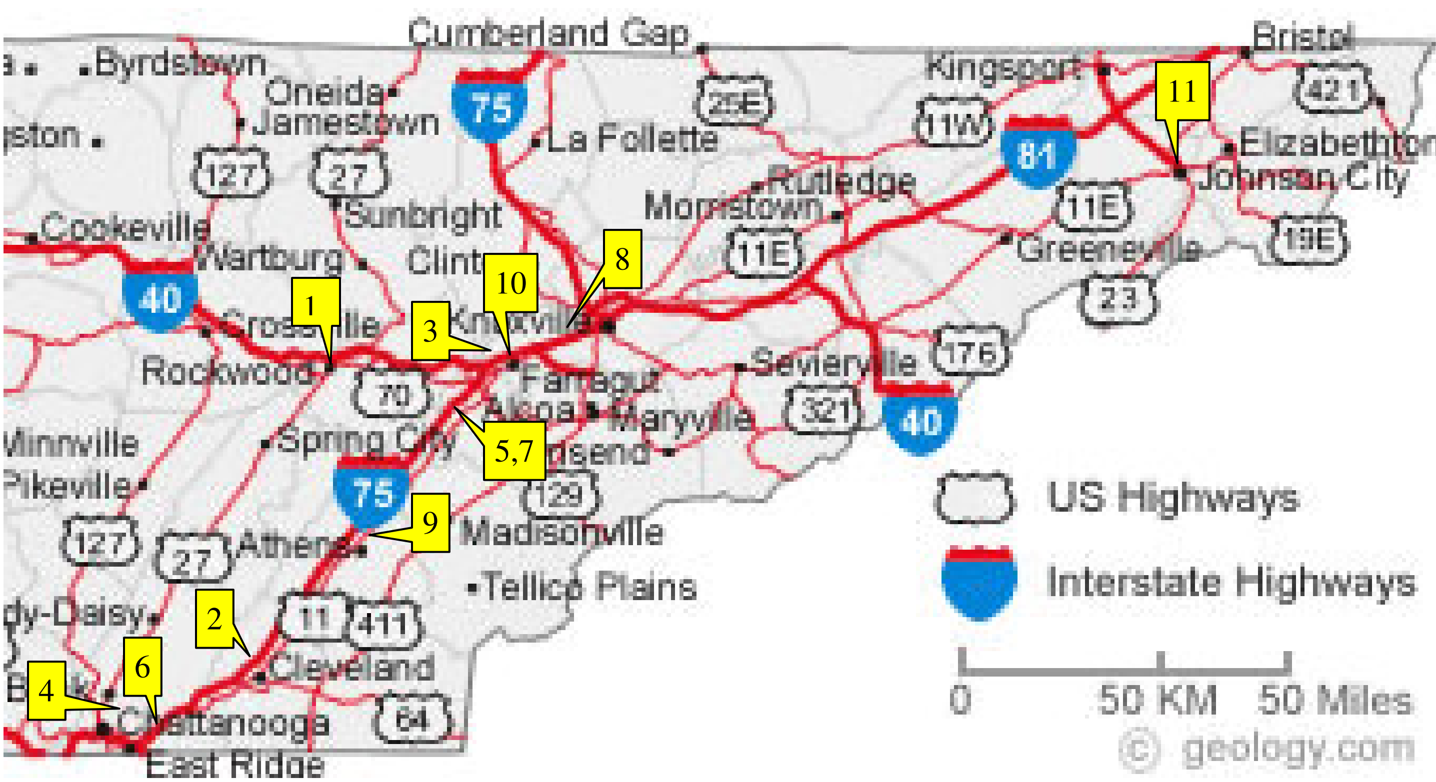
III. The TAOSON Signal

Our newsletter, the TAOSON Signal, will be published on a periodic basis as sufficient articles and other written contributions are received. Every effort will be made to protect the e-mail addresses on the distribution list and the privacy of their owners. Feel free to circulate and share copies of the Signal.

Items for the newsletter will be submitted by e-mail to Editor Bill Seymour at swafseymo@ bellsouth.net and to David Fields at fieldsde@aol.com. We encourage each active member to submit at least a paragraph that summarizes site activities, goals, and ideas. Members are also invited to submit questions to the Editor to be considered in the newsletter and at meeting

IV. Research Site Locations and Capabilities

TAOSON sites include those shown on the following map and identified in the following FACILITIES DIRECTORY.



TAOSON FACILITIES DIRECTORY

Site Location	Site Name	Code	Control Operator	Lat Long	Telephone	Operations
1 Rockwood	TAO	TAO	David Fields	35.8322 84.6175	865-376-1362	21 cm, 15m, optical, Ku, Spectracyber, Interferometer, IBT
2 Cleveland	SkyNet	SN	Bill & Melinda Lord	35.2427 84.8783	423-478-9043	21 cm, 15m, optical, Ku, Spectracyber, VLF (SID), FM Meteor, IBT
3 Solway	Solway	SOL	David Fields	35.9641 84.2021	865-927-5155	15m, Ku (2), optical, VLF, H-alpha
4 Hixson	Riverbend	RB	Dick Castle		423-870-4398	15m
5/7 Lenoir City	Lenoir City	LC	Aaron Haun		865-986-7153	Server, 15 m
6 Signal Mtn.	Mountain	MTN	Bill Seymour		423-870-8552	15m, optical, Ku, VLF (SID), IBT
8 Blue Meadow	Blue Meadow	BLM	Linda Fippin		865-539-0826	VLF
9 Niota	Niota	CL	John Mannone		423-337-2197	Ku, Optical, VLF, IBT
10 Karns	Karns	KA	Carl Lyster			Spectracyber, VLF
11 Johnson City	Johnson City	JC	Heather Fries			Quantitative optical, VLF (SID) planned
Puerto Rico	Puerto Rico	PR	Wanda Diaz			15 m, Spectracyber
UNAM, MX	Mexico	UN	Stan Kurtz			15m, Spectracyber, Homebrew IBT, SRT

V. Basic Research Activities at Tamke-Allan Observatory

See www.roanestate.edu/obs . Free Public Skygazes are conducted on the 1st and 3rd Saturday evenings of each month and TAOSON members are invited.

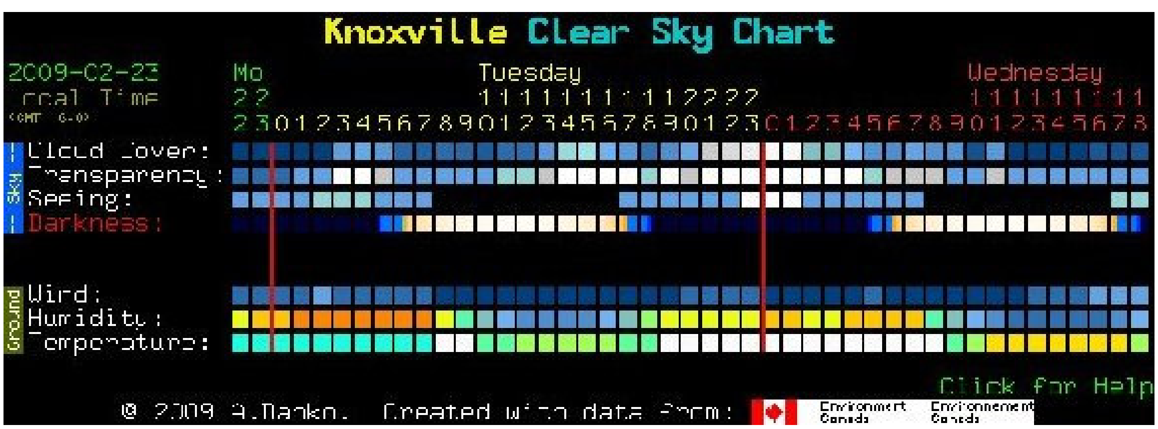
TAO is our primary meeting and workshop site. Capabilities include SpectraCyber, Jove system, IBT, Ku interferometer, and meteor bounce, plus optical equipment that includes an 8" refractor, 12" reflector scopes, Sky Scout, and spectrometers. SpectraCyber was built by Carl Lyster and used by Heather Fries last year for mapping.

TAO Site Report **David Fields**

This report is a look-ahead to Feb. and early March events, then a jump to September. We are planning observations. For both optical and radio observers, this brief Feb./March period is an interesting time. Radio observers have a solar-quiet period to try to catch some Jupiter signals. Plus there are radio pulses that may signal awakening of a new solar cycle. Or perhaps, the final echo of the last one?

Optically, the final weeks of Feb. are a chance to dust off telescopes to enjoy a dark moon that permits us spectacular views of both Saturn and Comet Lulin. My experience at 3 AM on 2/24 was dominated by thin cloud layer and lots of light pollution from Knoxville. Still, I found Lulin easily with binocs, both 7x35 and 15x50 (the latter much better). But no color and not much joy.

I usually use the TAO clear sky chart at www.roanestate.edu/obs but the Clear Sky Chart for Knoxville should be better for Solway. This is the Knoxville CSC that covers last night, and which shows the rotten



technical term) conditions around 0300-0500

For future opportunities and what TAOSON might do, consider the NASA LCROSS mission. Two lunar crater impacts are planned for Aug. or Sept., the first being a 2-ton Centaur rocket and the second, an instrumented probe. Analysis of the dust plume will provide composition data.

I speculate that there may be active radio emission with good signal/noise, based on the following considerations:
- we will know the impact time, so can look for a synchronous signal (pulse);
- active emission will be against a very low background, so S/N is good;
- the impact will be at night for us (I hope) so there will be no large competing solar signal;
- the impact vehicle would probably be charged from its journey, and an expected spark would send harmonics dependant on the size of the vehicle (fundamental resonance of 4xlength at max impact probe size. The probe is the 2300 kg spent Earth Departure Upper Stage (EDUS) -- about 10m for the Centaur rocket -- so the initial pulse might appear at 40 m wavelength, and higher frequencies;
- lunar dust probably has a stratified electric charge that would generate a noise pulse;
- lunar dust, like quartz, has triboelectric properties, etc. so electrical discharges would be expected; and
- lunar dust might accompanied by water vapor, since the impact will be into a dark polar crater.

We must ask if eruptions of such dust can produce electrical effects. The answer is yes. Consider

this, a 2006 photo of Chile's Chaitin volcano, which shows one or two lightning bolts;

So I expect that the LCROSS impact might yield a radio pulse with a lower frequency limit of about 7 MHz followed by a burst of white noise.

Our 15m (20 MHz) monitoring frequency would be an acceptable one to use for LCROSS monitoring, and using SkyPipe with accurate atomic clock synchronization, we would be able to identify any detected pulses. We’ve time to do some planning, so start thinking!

VI. TAOSON Projects

Radio Jove **Dick Castle, Jove Coordinator, K2IMH**

Welcome to the Radio Jove portion of the newsletter. Radio Jove is a NASA sponsored project to monitor the Sun and Jupiter at 20.1 MHz. It is teaching tool for radio astronomy for middle /high school, college students, amateurs and research groups. You build your own receiver and dual dipole antenna. Radio Jove web site is: **radiojove.gsfc.nasa.gov.**

The TAOSON group presently has 3 systems on-line with another being built. Sites are:

1. Harriman, TN - Tamke Allen Observatory- David Fields
2. Cleveland, TN - Skynet -Bill and Melinda Lord
3. Chattanooga, TN- Riverbend- Dick Castle
4. Signal Mountain, TN –Signal Mountain; Being built; expected to be operational in 2009 - Bill Seymour

Our objective is to monitor the Sun/Jupiter and see how the ionosphere affects the signals in different locations in close proximity. Data will be collected via Skypipe and sent to a server to be stored for analyses. TAO and Riverbend sites have been on-line (intermittently) since 2004. The Skynet Jove receiver has been recently built at Bill and Melinda Lord's with very high professional standards. Starting back in the fall last year they built a separate radio astronomy building next to their roll-off roof optical building. A dual dipole antenna was constructed and installed permanently. After that the Jove receiver was built and Skypipe software was installed on the computer. At this point we were ready to start collecting data. Early this spring we built Ten Tec 1056 receiver and then modified it for 20.1 MHz. We calibrated all three site receivers to Kelvin units on Skypipe using the Jove calibrator. A calibration procedure was also written. We have participated in four Radio Jove tele-conferences. These phone teleconferences bring together people from all over the world to discuss Sun/Jupiter events in real time. Presently we are in the process of building a portable dual dipole antenna system using fiberglass poles. The antenna system can be set up in less than 15 minutes and then be stored in a military bag for ease of carrying to outdoor events.

Itty Bitty Telescope (IBT) **Tom Crowley**

[Several TAOSON members are members of the Society of Amateur Radio Astronomers (SARA) and take part in the SARA Navigator Project. Through this project, TAOSON has borrowed SARA IBTs, Ku band radio telescopes. Tom Crowley, SARA President and Navigator Coordinator, has agreed to be TAOSON project coordinator for our IBTs.]

SARA is developing a **new** Itty Bitty Radio Telescope (IBT) for the International Year of Astronomy (IYA) 2009. Initial tests have shown the new instrument is capable of a 90% meter deflection when looking at the Moon with an 18-inch dish. Now that's radio astronomy! We are planning on developing two versions, one will be able to do a level of real science and the other will cost much less and make a great intro or demo telescope.

So just what is an IBT, you ask? It consists of a direct TV satellite dish and LNB, with the advent of High definition satellite broadcast many of these small dishes are being discarded. You or your neighbor may have a dish that's ready to be tossed, and may well do the "green" thing and recycle it to an IBT. You simply add a satellite detector from Ebay or Radio Shack or order a Channel Master 1040IFD tuning meter for under $80 on the web, build a base and you are ready to go.

If you are interested in building your own IBT check out:
http://www.aoc.nrao.edu/epo/teachers/ittybitty/procedure.html

Many SARA members have built IBT's and have had good success with them. SARA editor John Mannone has used an IBT to determine speed and Doppler shift of an automobile. All right -- not quite radio astronomy, but a unique experiment nonetheless.

For more information on the International Year of Astronomy check out:
http://astronomy2009.us

VII. Reports from The Sites

Solway Site Report **David Fields, N4HBO**

Temperature Measurements using Calibrated Thermistors

This writeup considers the importance of temperature measurement and how one may calibrate thermistors that can be used to take readings of equipment temperature, etc.

Thermistors are resistors whose resistance changes with temperature. But unless calibrated, they are useless. You can buy calibrated thermistors but they are very expensive. It's more fun to calibrate them yourself. We can have a calibration workshop at TAO sometime if anyone wants.

Example: Solar quiet-sun radio signal level is different before and after solar eclipse(!)
My most astounding astronomical discovery (not ;-) was made at Solway a few years ago during a solar eclipse. I found that solar quiet-sun radio emission did not return to the previous value after a solar eclipse(!) Data were taken from Solway during an interesting series of experiments to be discussed another time. The solar signal base line level did not return to the previous value after the eclipse – seeming to indicate an ionospheric change. Witnesses included Carl Lyster, Richard Sears, Scott Fields and Larry Robinson.

Or maybe the problem was that the receiver was sitting on the bench in the observatory and that the sun was heating it after the eclipse. Before the eclipse, it was in shadow. Yes, this turned out to be the answer!

The trouble was that the receiver temperature was changing! Using a thermometer to verify the temperature change confirmed this. Leaving the receiver in the sun was not a good idea.

Temperature Measurements using Thermistors
I prefer LCD thermometers, and use them a lot on equipment, etc. For more detailed measurements, I like thermistors. They can be placed almost anywhere and read remotely, provided that they have been calibrated.

They are cheap, but usually not cheap enough. But if you check prices at Electronic Goldmine, you can buy 5 for a dollar. That's my idea of cheap! So buy yourself some thermistors and have some fun with them.

Thermistor Calibration – the Thermistor Rose
You can calibrate thermistors by placing them in a bath of known temperature and measuring their resistance. Don't get them wet – cooking oil has some advantages. But this is tedious and the temperature changes rapidly if you use a small amount of oil. One needs a reservoir of oil, or a temperature-regulated bath.

I bought 10 thermistors and mounted them on a rotary switch so I could switch rapidly between them before the temperature of the calibration bath drifted. This evolved into a little flower:

This (the rotary switch with the thermistors) is my Thermistor Rose.

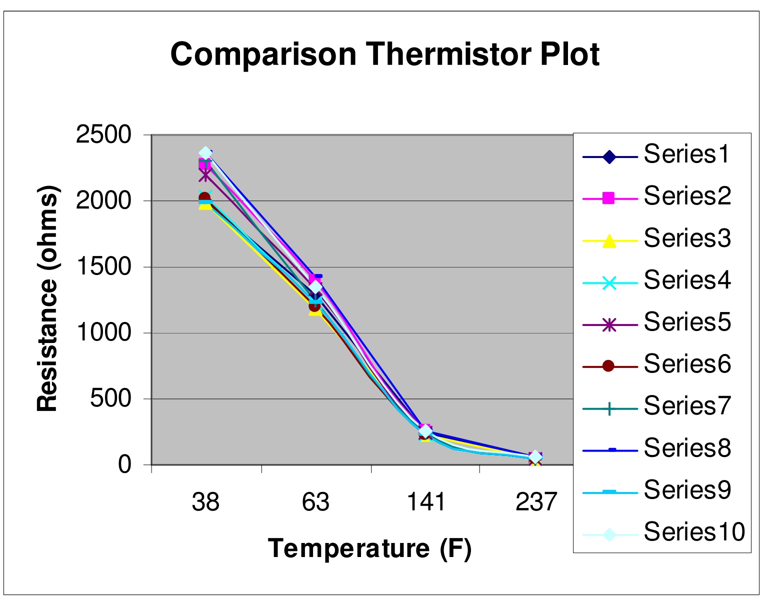
I used a large oil bath and measured all resistances at 4 temperatures: 38F, 63F, 141F, and 237 F
Apologies – I prefer Celsius but my thermometers were calibrated in Fahrenheit.

The data matrix obtained showed a lot of variation:

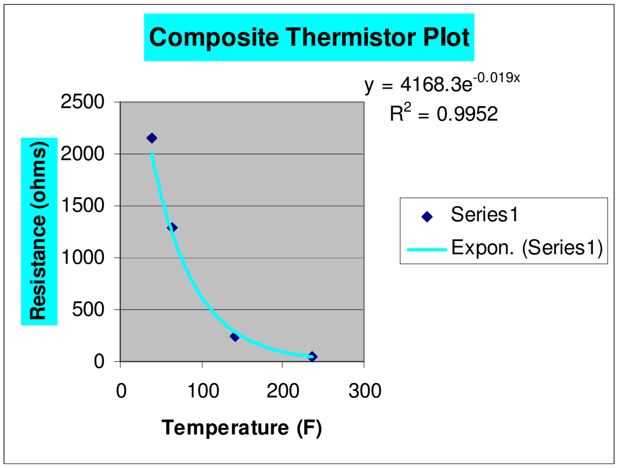
Thermistor	Ohms resistance at degrees F			
	38 deg	**63 deg**	**141deg**	**237deg**
1	2000	1292	238	47
2	2269	1400	256	50
3	1990	1183	226	45
4	2030	1220	230	48
5	2204	1330	243	50
6	2015	1190	225	47
7	2300	1240	245	50
8	2370	1430	255	54
9	1984	1232	223	51
0	2365	1350	252	57
AVE	2153	1287	239	50
STDEV	164	88	13	4

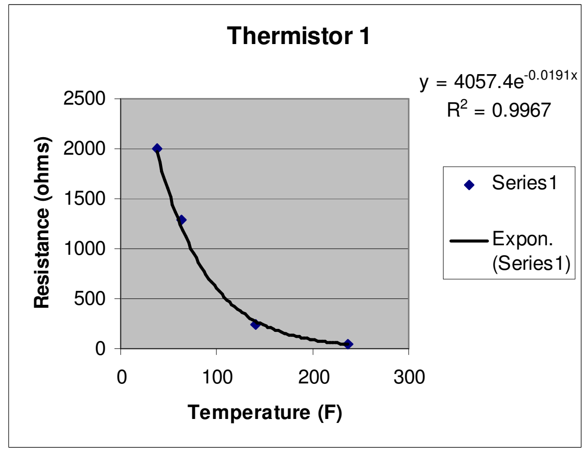
There is a lot of variation between thermistors, isn't there?

Resistance vs. Temp curves to show the consistency (or lack of) between thermistors:



That's not pretty, in part because the horizontal axis uses arbitrary data values. One can transform to a regular scale and fit to a curve. This works well if you choose the curve equation properly. The best fit is an exponential curve (2 parameter fit). I tried this with good results:





The above curve shows that the resistance values fall nicely on the curve. The curve on the left is for average values. The curve on the right is for an arbitrary thermistor (number 1).

I now have enough information to place thermistors anywhere (inside a preamp, for example) and read the temperature remotely using an ohm meter.

Relative measurements

There are a few interesting situations where we need to know relative temperature, and where we might even want matched thermistors.

To decide which thermistors are most alike, I wrote some equations that tell me when the thermistors are closely tracking together as the temperature changes. Then I calculated an objective relative error matrix where small values indicated small errors across the complete temp range. For my 10 thermistors, the matrix looked like this:

Objective relative error matrix (small values indicated small errors across complete temp range)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
2	0.34								
3	0.18	0.52							
4	0.12	0.40	0.12						
5	0.21	0.14	0.38	0.26					
6	0.14	0.47	0.06	0.07	0.33				
7	0.27	0.18	0.37	0.24	0.12	0.31			
8	0.49	0.15	0.67	0.55	0.29	0.62	0.45		
9	0.20	0.42	0.17	0.12	0.28	0.14	0.12	0.53	
10	0.47	0.24	0.65	0.53	0.27	0.60	0.43	0.14	0.51

I didn’t show cell n,n in which values are 0.0. Look for the low numbers which show matched pairs. They demonstrate that thermistors 1 and 3 are alike, and 8 and 10 are alike, but that I shouldn’t try to match up 1 with 2 or 1 with 10 etc.

Summary

One needs to calibrate thermistors before they are needed. So give it a try and I’ll share my Excel programs with you. Or I’ll even share my thermistors! Have fun!

VIII. Radio Astronomy Basics

Minimum Detectable Signal

The Amateur Radio Astronomer may sometimes want to know the “minimum detectable signal” on a particular radio telescope system, approximated by the diagram below.

ISignal GeneratorI>>IReceiver “Square Law”DetectorI>>IOutput DeviceI

Listed below are some quick, “back-of-the envelope” approximations obtained by using the following steps:

1. Determine the bandwidth of the entire receiver chain empirically; e.g. 500 MHz to 600 Mhz at the half power points (a rule of thumb).
    a. The basic procedure is to insert a known level of a variable frequency voltage (from a signal generator) into the input of the receiver and to monitor the output device.
    b. The output device could be an analog meter or chart recorder, or analog-to-digital converter feeding a computer, etc.
    c. Set the signal generator for cw (continuous wave) operation, and the output level control at some realistic value, such as 5 microvolts (uV). Vary the frequency until there is a definite response in the output device. Assuming a nominal value of 500MHz to 600 MHz in the receiver operating frequency, adjust the generator frequency accordingly, i.e. 550 MHz. Increase the generator output in 5 uV increments until an indication is produced in the output device.
    d. Determine the frequency, call it Fc, of the receiver’s pass band at which the indication on the output device is a maximum. (But, this need not be full scale deflection. In fact, a deflection of 90% full-scale is more convenient to assure the operator that the receiver is not being over-driven.) Designate this voltage as Vmax.
    e. Then vary the signal generator frequency (but not the signal generator output voltage) **below** Fc until the output device reads approximately

0.5 Vmax. Designate this frequency as FL—this is the lower half power point.

f. Then vary the signal generator frequency (but not the output voltage) **above** Fc until the output device again reads approximately 0.5 Vmax. Designate this frequency FH. This is the upper half-power point. Assuming that the detector is operating in its "square law" region, the bandwidth of the receiver is taken to be FH-FL. (For example, FL could have been 3.5 MHz below Fc and FH could have been 3.8 MHz above Fc. In this case, the approximate bandwidth is 7.3MHz.

2. Determine empirically the minimum detectable signal referred to the input of the receiver. What change is needed at the input connector of the receiver to notice any change in the output device?
   a. Adjust the generator's output control to minimum and frequency to F.
   b. Then vary the generator output voltage to a level which just produces a noticeable deflection in the output device. This could occur, for example, at 3.2 uV (RMS).
3. Calculate the minimum detectable noise power at the receiver input.
   If the receiver has a coaxial type of input, e.g. BNC or N, then the input impedance is nominally 50 ohms. Since the minimum detectable voltage has been determined in Step 2.b. above, then the power level in this resistance can be determined: It is simply the square of the voltage (its RMS value) across the impedance divided by the impedance; or, 3.2 squared/50= 0.2 picowatts (pW) of power. This represents the "average" level of noise needed at the receiver before anything can be seen at the output device.
4. Calculate the power-noise intensity required at the antenna that will produce 0.2 pW at the input to the receiver (Recall that intensity is the number of watts per unit area per unit frequency coming from the radiation source at the measuring point).

Example:
Using a 2-meter diameter dish antenna with an area of approx.3.1 square meters.

Practical corrections which must be made up front;
--The radiation source is probably randomly polarized in space, whereas our antenna feed is a linearly polarized device--this means that only one-half of the incoming radiation can be used and our dish antenna aperture is effectively smaller by a factor of two.
--Also, antenna illumination inefficiencies require another multiplication factor of two.
In the final calculations, the required intensity over a 1 MHz bandwidth will be obtained by dividing by 7.3 MHz [The bandwidth – def]

Combining all of these items into one equation gives the following relationship;

$2 \times 2 (0.2/3.1) / 7.3 = 3.5 \times 10^{-20}$ W/ m^2 -Hz

This is a “back-of the-envelope” approximation of the MINIMUM intensity of radiation that a radio telescope described above needs to intercept in the frequency range consistent with its operation. Note that this estimate just described allows for the possibility that the pass-band is not perfectly symmetrical around some central frequency. Notice also that we are assuming that there are no other complicating features (such as “ripples” in the pass-band) concerning the band-pass characteristics. Finally, it should be noted that the chances are that the detector is not operating in its “square law” region. As a rule of thumb, therefore, the “half-power” points are likely to be at 0.7 Vmax rather than 0.5 Vmax.

Reference: Radio Astronomy Projects; A Hands-on Guide to Exploring the Radio Universe; Third Edition; William Lonc

IX. Notable Quote

“Science is an integral part of culture. It is not this foreign thing, done by an arcane priesthood. It is one of the glories of human intellectual tradition.”
--Stephen Jay Gould, 1941-2002; in INDEPENDENT, 24 January, 1990.

X. Links to Radio Astronomy Resources

A. From Jim Brown, SARA Mentor

Something new folks might like to listen in to.

SOMETHING NEW: For the new year, Spaceweather.com is pleased to announce a new service: Space Weather Radio, broadcasting live "sounds from space" around the clock. Today you can listen to the Air Force Space Surveillance Radar in Texas. When a meteor passes over the facility--ping!--there is an audible echo. (Activity should be high during the Quadrantid meteor shower this weekend.) In the near future we'll be adding broadcasts of solar radio bursts and VLF signals from the ionosphere. The streams are punctuated by Daily Space Weather Updates from Dr. Tony Phillips. Click here to begin listening: http://SpaceweatherRadio.com

Happy New Year.

B. From Cliff Bates KC7PPM crcwnet.com

A Basic Primer on Setting Up An Amateur Radio
Radio Telescope; 17 Pages

"This is a primer about getting started in Amateur Radio Astronomy (RA), and is mostly based on the school of hard knocks and mistakes I have made over the last 4 years since I have been interested in RA. Hopefully, after reading this, those of you who are up and coming will not repeat my mistakes and thus save yourselves not only a bit of frustration, but considerable money."

C. Radio Jove web site: radiojove.gsfc.nasa.gov.

D. International Year of Astronomy: http: //astronomy2009.us

E. Society of Amateur Radio Astronomers: www.radio.astronomy.org

XI. A Professional-Amateur Dialogue

Amateur vs. Professional Radio Astronomy

by
Rodney Howe
Stan Kurtz (UNAM, Mexico) and
David Fields (Tamke Allan Observatory)

Editor's Note: Stan Kurtz has been gracious to give some of his professional time and ideas in reviewing an interesting amateur radio astronomy research proposal submitted by Rodney Howe in the December, 2008 Issue of the TAOSON Signal ("Looking for Collaborators to Work on A Research Project for Dark Matter Detection"). Also, thanks to David Fields for review, editing, and comments. The rare interactions between professional and amateur radio astronomers can be very valuable and greatly benefit the amateur community by giving a deeper and grounded scientific perspective to original amateur concepts.

Rodney started the discussion by sending a nice letter to the Signal describing a radio astronomy research project and inviting people to collaborate. Follow-up correspondence between David and Stan has been woven together as a narrative.

Rodney suggested..."it may be that the HI clouds represent a form of cold 'dark matter' in the Milky Way."

This is an interesting question, and points up the possibility of 'new physics' hiding in the data. David asked if both amateurs and professionals might search for additional physics in the HI signals -- if electrostatic forces may be relevant; i.e., if photon pressure could produce a streaming of electrons from central bright masses. Such a mechanism would apply for stars and for galaxies but be only detectable over large distances (galaxies) or for certain unusual situations (Voyager path orbital mechanics). The central bright mass would end up positively charged and the outer regions would be negative. The net imbalance wouldn't be great, but would result in centrally-directed attractive force. This is what we observe in galaxies - a non-Keplerian central force that we interpret to be dark matter. Couldn't it be just electrostatic? And if so, would the electric fields produce a Stark effect on the HI signals? The question has relevance to both the dark-matter challenge and the Voyager challenge.

Stan's reply focused on the nature of HI: Hydrogen isn't "dark matter"; it's quite easy to see. It exists in neutral (HI), ionized (HII), and molecular (H2) forms. The latter can't be directly seen in radio (although it can be seen in the infrared) because it's a symmetric molecule (and hence it has no dipole moment or dipole transitions). But CO is a fairly reliable surrogate for molecular hydrogen, and CO can be seen in radio. Literally tens of thousands of hours of professional telescope time (radio, IR, visible) have gone into mapping hydrogen in the Milky Way. Even a well-funded, well-equipped, and very dedicated amateur group is unlikely to find hydrogen that the professionals have overlooked.

Rodney commented later in the discussion about the low H velocities seen in the HI data: "Data from the center of the galaxy show a narrow peak of unmoving HI clouds."

Stan pointed out that the velocity field in the galactic center is a bit complicated. On a large (~500 parsec) scale the overall velocity average is zero. But this is because the velocity field ranges from about -250 to +250 km/s. It's not that the gas isn't in motion, but rather that it's AVERAGE velocity is about zero. This is shown fairly well in figure 2, where the emission is centered at 0 km/s. In the spectrum of figure 2 the emission seems to span a range from about -30 to +30 km/s. Presumably this is a sensitivity/resolution issue, since professional observations of the galactic center show emission from -250 to +250 km/s, albeit at lower intensity.

The velocity field of the Galaxy has been very extensively studied.
Outside of the nuclear bulge, the disk more-or-less follows differential rotation. That is, it rotates - but not as a rigid body, for which the further you get from the center the faster the tangential velocity is. There are some significant deviations from this circular motion, and these are not fully understood. But if one wants to study this, the best way would be to start with existing, published data, which show the velocity field of Galactic hydrogen with far more completeness and precision than the most dedicated and well-funded amateur group might ever hope to achieve.

Most of the large Galactic neutral hydrogen surveys are publicly available. Anyone can download the data and analyze them. If someone has an ingenious idea about Galactic rotation models, the simplest and fastest approach would be to use existing data to see if the model can explain them.

Rodney commented on the size of the HI peaks: "In figure 3, both the larger area under the curve and the velocity of approaching clouds might be an indication of a larger quantity of HI clouds..."

Stan commented on the difficulty of measuring the mass of the HI clouds using the HI signal curves: The velocity itself does not indicate quantity of gas or number of clouds. Multiple velocity components probably does indicate multiple clouds, but doesn’t indicate how much mass they contain.

The area under the curve is related to the quantity of gas, but in a non-trivial way. For example, without making the calculation, there's no way of knowing if the left peak or the right peak of figure 3 represents more mass, although the area under the left peak is much greater than the area under the right peak.

With respect to "…differences in the magnetic structure between the outer and inner galactic arms, which can help determine the temperature and quantity of HI in these outer arms?" Presumably "determines" means that the B field 'controls' the temperature/quantity of HI rather than if the B field will help us 'measure' the temperature/quantity of HI. In either case, the answer is pretty clearly 'no'. Extensive studies have been made of the heating and cooling of HI clouds, and the magnetic field is not a significant factor. The quantity of gas can be influenced by the B field, but it isn’t a dominant factor. Gravity and spiral density waves are much more important.

Regardless of whether Galactic HI or B fields trace dark matter, differences in the polarization observed toward different parts of the Galaxy is a very interesting and worthwhile topic of study. But isn’t at all clear that HI is the way to go about it. The polarization will be much greater (and hence easier to measure) if one looks at synchrotron radiation in the continuum. Even then, it won’t be easy. There are all kinds of instrumental effects that can confuse the measurements, and it is a very difficult challenge to account for all of these. Professionals, with big budgets and full-time engineering staffs, can work for years to overcome these problems.

David went back to the question of whether amateurs might be able to study polarization with simple measurements: I think that amateurs can overcome these instrumental effects, but not the effect of intervening matter. I think that the B field would polarize the atomic spins, and the HI radiation, so we could determine the direction of the B field. Am I wrong? I don't find anything on this in Kraus's book. It's a hyperfine transition inside an S electron state, but I think that the unpaired electron would be polarized. I did an Internet search and found one article, http://adsabs.harvard.edu/abs/1988A&A...198..249L that deals with the polarization. This supports Stan’s idea that the measurement is difficult to make and interpret. (Stan adds: a good reference on using the Zeeman effect with HI to determine the Galactic B field can be found at:
http://adsabs.harvard.edu/abs/1995ApJ…451..624V
The article gives some good background and discussion of the observational problems. A companion article presents the results:
http://adsabs.harvard.edu/abs/1995ApJ…451..645V)