Don Lancaster's

Tech Musings

November, 1997

Time saving laser printer testers
More on hydrogen developments
Inside a submillimeter telescope
Home Power's new SOLAR II CD
Radio astronomy resources update

This month, we seem to have a fascinating collection of both pseudoscience and real science topics. Let us start off with the real stuff…

Radio Astronomy

That world class *Henrich Hertz* SMT submillimeter telescope lies on a small hill in front of my driveway. I recently wrangled a special insider tour. Because it was our monsoon season and between experiments, I even got to get a real close look at what's happening inside the receiver pods. There is some amazing stuff coming down here.

A *radio telescope* is just a big old radio receiver. One that's extremely directional, low in noise, and quite sensitive. They are sometimes used singly. But they might get grouped together into *arrays* using a magic process called *interferometry*.

Some radio telescopes investigate solar and planetary phenomoma in the high frequency range. Others use ordinary microwaves in the 300 MHz to 150 GHz microwave range. 300 Gigahertz has a wavelength of one millimeter. The latest of specialized radio telescopes go well under this one millimeter wavelength, exploring the Terahertz *mystery band* that we looked at back in HACK84.PDF and EMERGOP4.PDF.

Things get especially challenging in this 100 to 1000 Gigahertz range. First, you must have a quite dry and very high site. Hence the 10,700 foot high hill that blocks my view to the south. Water vapor severely absorbs submillimeter signals. Your receiving dish has to exceptionally conform to its parabolic shape, say a thousandth of an inch or better over thirty five feet. Day in and day out.

You have to work around all the restrictive atmospheric windows that get in your way. And the receiving electronics often has to be chilled to nearly absolute zero. And, oh yeah, nobody yet knows how to construct decent mystery band amplifiers or even power sources. So you are still stuck with a highly noisy and klutzy electronics technology that today is roughly comparable to microwaves before 1940. Literally a crystal set.

And therein lies a few of the SMT challenges.

If you ever want to make friends with a radio astronomer, offer them stable one Terahertz amplifiers with 20 decibels of gain and an 0.8 decibel noise figure. At $4.98 per dozen.

Although these new millimeter and submillimeter telescopes can be used for SETI extraterrestrial intelligence searches, most traditional researchers distance themselves from anything related to "E.T. phone home".

Instead, they concern themselves primarily with mapping apparently natural instances of extraterrestrial radio noise sources. One important source for these signals is known as *molecular resonance*.

Two of the most popular are the 21 centimeter hydrogen line at 1420 Megahertz and that 18 centimeter hydroxyl line at 1681 Megahertz. The area between these two makes up a transparent window that's nicknamed the *water hole*.

The presence of energy at or near a molecular resonance usually reveals the presence of that molecule.

Because of a "red shift" *Doppler effect*, modest frequency differences from what is expected can tell you whether an energy source is moving towards you or away from you. Other radio energy sources are associated with pulsars, quasars, black holes and supernovas. They often paint a wildly different picture of the universe than optical telescopes do.

I've summarized some other key molecular resonance frequencies for you in figure one.

The SMT

This particular SMT handles radio astronomy wavelengths from 0.3 to 2 millimeters. Or frequencies from 150 Ghz to 1000 Ghz. The latter being a full Terahertz. Thus, this scope starts where older millimeter instruments have left off.

The 35 foot dish is in fact accurate to a mil or so. Specifically, their goal was 15 microns of rms error (there's about 18 microns in a thousandth of an inch). Stats are currently under

Deuterium	327.384 MHz	Carbon Monosulphide	48.991 GHz
Hydrogen	1420.406 MHz	Hydrogen Cyanide	88.632 GHz
Hydroxyl	1612.231 MHz	Carbon Monosulphide	97.981 GHz
Hydroxyl	1665.402 MHz	Carbon Monoxide	109.782 GHz
Hydroxyl	1667.359 MHz	Carbon Monoxide	110.201 GHz
Hydroxyl	1720.530 MHz	Carbon Monoxide	115.271 GHz
CH Radical	3263.794 MHz	Formaldehyde	140.840 GHz
CH Radical	3335.481 MHz	Duterated H Cyanide	144.827 GHz
CH Radical	3349.193 MHz	Formaldehyde	140.840 GHz
Formaldehyde	4829.660 MHz	Carbon Monosulphide	146.969 GHz
Water Vapor	22.235 GHz	Formaldehyde	150.498 GHz
Ammonia	23.694 GHz	Carbon Monoxide	219.560 GHz
Ammonia	23.723 GHz	Carbon Monoxide	220.399 GHz
Ammonia	23.870 GHz	Carbon Monoxide	230.538 GHz
Excited Hydrogen	36.466 GHz	Methanol	258.507 GHz
Silicon Monoxide	42.821 GHz	Hydrogen Cyanide	265.886 GHz
Silicon Monoxide	43.122 GHz	Carbonyl Sulfide	461.907 GHz

Fig. 1 – SOME MOLECULAR RESONANCE FREQUENCIES of interest to centimeter, millimeter, and submillimeter radio astronomers.

SOME RADIO ASTRONOMY RESOURCES

Caltech Submm Obsty
111 Nowelo St
Hilo HI 96720
(808) 935-1909

Discovery Park
1651 32nd St
Safford AZ 85546
(520) 428-6260

Harvard Submm Array
60 Garden St
Cambridge MA 02138
(617) 495-7489

Hat Creek Observatory
42231 Bidwell Road
Hat Creek CA 96040
(916) 335-2364

IEEE Press
445 Hoes Ln
Piscataway NJ 08855
(908) 981-0060

IEEE Trans Microwaves
445 Hoes Ln
Piscataway NJ 08855
(908) 981-0060

Int Jl Infrared & mm Waves
233 Spring St
New York NY 10013
(212) 620-8000

Jet Propulsion Laboratory
NASA
Pasadena CA 91109
(818) 354-5011

NRAO Observatory
PO Box 2
Greenbank WV 24944
(304) 456-2011

Radio Astronomy Supplies
190 Jade Cove Drive
Roswell GA 30075
(770) 992-4959

Radio Sky Publishing
PO Box 3552
Louisville KY 40201
www.win.net/~radiosky

SETI Institute
2035 Landings Dr
Mountain View CA 94043
(415) 961-6633

SETIQuest
174 Concord St
Peterborough NH 03458
(603) 924-9631

SMT Telescope
University of Arizona
Tucson AZ 85721
(520) 621-5290

Soc Amateur Radio Astron
247 N Linden St
Massapequa NY 11758
(516) 798-8459

VLA Astronomy Site
PO Box "O"
Socorro NM 87801
(505) 772-4011

twenty microns or so and improving. At present, this is the finest SMT dish anywhere in the world.

This dish is set up as an AZ-EL mount, an abbreviation for *azimuth and elevation*. Most of the azimuth part is handled by *rotating the entire building!* Special "windup" cables and flexible pipes let their building spin 270 degrees in either direction. At a 60 degrees per minute clip, even. Elevation is handled by tilting the dish over an -2 to 91 degree range.

There is a secondary *Cassegranian* reflector way out in front near the parabolic dish focus. Reached by a scary circus tightrope platform. The secondary in turn will reflect their received beam on down through the middle of their dish. At that point, a flippable mirror then deflects their beam out a chosen end of the *middle* of the elevation *axle*.

The beam then goes to one of two *receiver pod* rooms. The neat thing about this setup is that the intended receivers can be bolted down onto fixed optical benches in more or less ordinary rooms. With use of beam splitters, up to six experiments (three on each side) might get conducted nearly at once.

The secondary reflector also gets used for minor tracking (ever try to smoothly move a building by a few microns at a time?). The secondary is also used to purposely switch on and off axis, modulating your beam for better detectability. This is an update of the ancient astronomical "blink comparator" technique. Their typical chopping frequencies are 10 Hertz or 25 Hertz, depending on need.

I'm also told you can hang a dipole on the secondary to make a dandy two meter ham receiver. Their 200 mile line-of-site visibility does not hurt DX all that much, either.

Back in the receiver rooms, two different technologies can be used at one of the six selectable focal points. Several frequencies can be monitored at once. A *bolometer* is a broadband heat detector. It can determine the overall energy being received.

The other option can be a tunable superhetrodyne receiver. Their *Gunn* diode oscillator and multiplier chain generates a frequency near that of the intended reception frequency.

This *local oscillator* frequency is beamed together with the received signals through a window onto a supercooled SIS tunnel junction diode. The two beams interact with the diode's nonlinearity, producing sum and difference signals. The new difference signal gets routed to a microwave intermediate frequency amplifier chain.

From there, the received signal is further downconverted, is amplified, filtered, and then gets digitally signal processed. The usual output is in the form of an intensity map.

Often in pretty false colors.

Ah yes, the cooling. Much of the universe lies at a "night sky" temp of 4.5 degrees Kelvin. Four degrees above absolute zero. Ideally, your detector should be substantially *less* than this value. Critical portions of the receiver electronics are placed in special *Dewars*. These are related to plain old thermos bottles, but might be the size of a commercial soft drink supply cannister.

Liquid nitrogen is first used as an intermediate cooler. It turns out that ordinary liquid helium-4 boils at 4.22 degrees Kelvin. But there is a magic and stupendously expensive helium-3 isotope which boils at a significantly lower temperature. By evaporatively diffusing helium-3 into helium-4, a special cyrogenic referigation device offers cooling to *within a fraction of a degree of absolute zero*.

Since there is only one naturally occuring helium atom out of 10,000 that is this magic helium-3, special and elaborate recycling compressors recover and reuse this elixir.

The SMT's website is located at *maisel.as.arizona.edu:8080*. Bunches more info here. Seasonal Saturday

NEED HELP?

Phone or write all your US Tech Musings questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher, AZ, 85552
(520) 428-4073

US email: *don@tinaja.com*
Web page: *www.tinaja.com*

NAMES AND NUMBERS

Alsa Softouch
2640 E 37th St
Vernon CA 90058
(213) 581-5200

Applied Microwave & Wireless
2245 Dillard St
Tucker GA 30084
(770) 908-2320

Hitachi
2000 Sierra Point Pkwy
Brisbane CA 94005
(415) 589-8300

Home Power
PO Box 520
Ashland OR 97520
(916) 475-3179

Innovation
2011 N Shoreline 21L-415
Mountain View CA 94043
(415) 933-6502

KeelyNet BBS
Box 1031
Mesquite TX 75149
(214) 324-3501 BBS

Langmuir Labratory
NM Inst of Min & Tech
Socorro NM 87801
(505) 835-5423

Laser Wizard
705 G Washington Ave
Norristown PA 19403
(610) 539-4708

Lindsay Publications
PO Box 538
Bradley IL 60915
(815) 935-5353

Newnes
313 Washington Street
Newton MA 02158
(617) 928-2500

Recharger
4218 W Charleston Blvd
Las Vegas NV 89102
(702) 438-5557

Ricoh
3001 Orchard Parkway
San Jose CA 95134
(800) 957-3436

Science/AAAS
1333 H St NW
Washington DC 20005
(202) 326-6400

Sharp
Sharp Plaza
Mahwah NJ 07430
(201) 529-8757

Synergetics
Box 809
Thatcher AZ 85552
(520) 428-4073

Texas Instruments
PO Box 809066
Dallas TX 75380
(800) 336-5236

Don Thompson
6 Morgan #112
Irvine CA 92718
(714) 855-3838

Wireless Design & Dev
301 Gibraltar Dr
Morris Plains NJ 07950
(201) 292-5100

tours are available through the folks at *Discovery Park*. All day tour costs are around $30. More details on tours and their amateur astronomy club at *www.discoverypark.com*

Some Resources

A superb collection of state of the art submillimeter receiver papers is available for your free downloading at *cfarx1.harvard.edu.ix_lab/papers* For lots more, just search the web under "submillimeter".

I have gathered a few additional radio telescope names and numbers for you as this month's resource sidebar. One good starting point is the *NRAO at info.aoc.nrao.edu*

That VLA outside of Magdalena, New Mexico is certainly worth your visit. Little known near here is the secret *Langmuir* thunderstorm lab on the next mountain over; even lesser known is that summer visitors are welcome to this remote site.

There's also a *Society of Amateur Radio Astronomers*. An individual by the name of Jeffrey Lightman now publishes *Amateur Radio Astronomy: Systems, Procedures and Products*. It is sold through his *Radio Astronomy Supplies*. Cost is $40. He also carries the Robert Sickels *Radio Astronomy Handbook* at the same price. Plus lots of other books, videos, hardware, and software. A 1420 Megahertz receiver sells for $1420.

One good journal I've found on submillimeter receiver technology is the *International Journal of Infrared*

and Millimeter Waves. And the *IEEE Transactions on Microwave Theory and Techniques* is also useful.

Many hundreds of radio astronomy books are stocked by Amazon Books at *www.amazon.com* One pricey title is *Instrumentation and Techniques for Radio Astronomy* from the folks at the *IEEE Press*.

As to amateur astronomy resources in general, I have just posted a hot linked download as RESBN67.PDF on my *http://www.tinaja.com*

A Clarification or Two

Uh, whoops. The energy density figures in my recent hydrogen story were high by 1000. Hydrogen has an energy density of around 38,000 *watt* hours per liter or 38 *kilowatt* hours per liter. All these values have been corrected in MUSE115.PDF.

Sorry about that.

One individual was critical of my failing to include *Brown's Gas* in my recent hydrogen story. Brown's Gas is a stochiometric mix of two parts of hydrogen to one part of oxygen. It sees some limited commercial use in specialized welding torches.

But unquestioning Brown's Gas enthusiasts make outrageous claims, such as overunity energy production, radioactive waste neutralization, and even negative pressure generation.

All without credible and verifiable proof to any acceptable standards. At least none that I've seen.

I strongly feel that Brown's Gas clearly passes my subjective "looks like a duck - quacks like a duck - is gonna lay some eggs" pseudoscience test. If for no other reasons, because of the outlandish claims and nature of the totally clue-challenged denizens it attracts to the web.

Pseudoscience is a field I closely monitor. Because it includes such mesmerizingly awful fiction.

Stuff that is not even wrong.

If I ever do discover any credible evidence to the contrary, I'll be most happy to research Brown's Gas in more depth and thoroughly report it. I do not expect this to happen until after the Ayatolla's bar mitzvah.

More on *tinaja.com/pseudo01.html*

New Tech Lit

There's a whole flock of new and free CD ROM data disks this month: From *Texas Instruments*, the *Logic Selection Guide and Data Book*. Or from *Hitachi*, their *H8/300 Series Embedded Microprocessors*. From *Sharp*, a *Flash Memory Data Book*. And from *Ricoh*, full details on *CD Recording Media*

Home Power magazine has newly come up with their greatly improved *Solar 2* CD ROM. This one uses the latest version of *Acrobat* for totally searchable and full color images of 3900 pages of Home Power. From Issue #1 through #42. Topics include everything from photovoltaic cells on up through electric vehicles to solar cooking to water pumping and more.

$29 including US shipping.

Several exciting new laser printer repair instruments are newly offered from *Laser Wizard*. These calculator size units plug into popular *Canon* engines and give you all sorts of new found diagnostic and control powers. Their PIC-based $295 SX30 is the basic unit for SX engines. Add-on $99 adaptors are available for the NX and BX engines. These can let you manually control the printer at the engine level while overriding cover switches and reading error messages.

Laser printer training and repair parts still remain available from *Don Thompson*, while cartridge refilling opportunities abound in *Recharger* magazine ads and stories.

More on the neat things you can do with toner in RESBN68.PDF.

Free samples of a new ultra-tough *Softouch* leather-like coating from *Alsa*. Freebie electrochemical milling samples from *Fotofabrication*.

New books from *Newnes* include an *Inside PC Card Design* by Faisal Haque and *Cellular Telephones and Pagers Overview* by Steve Gibson.

The latest of "new" old titles from *Lindsay Publications* do include *I.C. Engines Volume I*, his collection of patents on early internal combustion engines. And new books on lathes, saw blade, and milling machines.

Url is *keynet.net/~lindsay*.

There is a brand new *Innovation* publication for you users of high end graphics computers. It is apparently a continuation of an older *IRIS Universe* magazine. Free subs to those with a genuine interest.

Two useful wireless trade journals are *Applied Microwaves & Wireless* and *Wireless Design & Devleopment*.

For the insider secrets of starting up your own technical venture, see my *Incredible Secret Money Machine II*. From my nearby *Synergetics* ad. You can also preview the intro at my *www.tinaja.com/ismm01.html* Also check my new *Infopack* service that quickly gives you custom and cost effective research solutions.

As usual, most of the mentioned items should appear in the *Names & Numbers* or in the *Radio Astronomy Resources* sidebars. Always do check here before you call our US technical helpline shown in the *Need Help?* box you'll find nearby.

Let's hear from you. There's lots of new opportunities here. ✦