

Radio Astronomy Radiometers, Dipoles, Pulsars

Greg Taylor University of New Mexico

Astronomy 423 at UNM Radio Astronomy



Identify 7 projects and the teams:

Projects	scheduler	member	member	member
Cas A	Brett	Christina	Raman	
Cyg A	Alexandra	Stephanie	Dylan	
M87	Isabela	Alexis	Aniketh	
Jupiter-team2	Lily	Sharleen	Yifu	
Starlink	Ella	Jacob	Sarah	
Sag A	Rachel	Annalisa	Madeline	Mark
Jupiter-team1	Charlie	Sara P.	Joaquin	

Please get together as a team and plan your observationsSchedules should be submitted by Feb 17 and completed byMarch 15.Each project can have up to 10 hours of LWA observingProject code: DA004 UserID: 76





Announcements

Contact info:

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Sampling Radio Astronomy Notes S-6 voltage 4ime
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Series
$$V(t) = \frac{R_{x}}{R_{y}} \frac{TF}{R_{y}} V(t) = V(t)$$

$$V(t) = \frac{R_{y}}{R_{z}} \frac{R_{z}}{R_{z}} \frac{TF}{R_{z}} \frac{R_{z}}{R_{z}} V(t)$$

$$V(t) = \frac{R_{z}}{R_{z}} \frac{R_{z}}{R_{z}}$$





Radio Astronomy Notes 6-/ Radiometer 5 AF RX ULD intyrate v(t) V(4)

Incoherent radiometer: Like a square law desector also - bolometer, basically broad-band calorimeters Focal Plane Amongs of bolometers useful at high V

Cohurant radiometer: Proserve phase information \$(+)







Auto Corrulation





Figure 12.6 MATLAB plot of the 3-D normalized field polar radiation pattern of a Hertzian dipole (Fig.12.1); for MATLAB Exercise 12.17. (color figure on CW)





Figure 12.7 Cuts in three characteristic planes of the radiation pattern in Fig.12.6; for MATLAB Exercise 12.17. (color figure on CW)



Hertz Dipole







G. Taylor, Astr 423 at UNM

LWA Antenna







20 MHz 3D



E and H-Plane Antenna Pattern







Radio Astronomy Notes G-SGain for a Dypoly Ant and $\frac{A_{e} \Lambda_{a}}{\int_{1}^{2}} = 1$ gain $g = \frac{dP/dr}{P/47r} = \frac{47}{ra}$ = YAAL Hute Dipole Ae= $\frac{3}{871}$ $l^2 = \frac{l^2g}{44}$ $g = \frac{3}{7}$ Ae= gli g=3,5 for LWA anying Act 10 m² at 6m wavelingth Station Aei 10m2, 256 = 2560 m2 at 50 mHz $G = \frac{A_{1}}{2k} - \frac{2560 \text{ m}^{2} (100)^{2} \text{ cm}^{2}}{2 \cdot 1.381 \times 10^{-16} \text{ erg}} \cdot (0^{-23} \text{ rg} \text{ s}^{-1} \text{ cm}^{-2} \text{ Hz}^{-1}$ G = 0,93 K/Jy SEFD= TSYS = 6000 K = 6.5 KJy 0,93K G



10-88 MHz usable Galactic noise-dominated (>4:1) 24-87 MHz 4 independent beams x 2 pol. X 2 tunings each ~16 MHz bandwidth SEFD ~ 9 kJy (zenith)

All sky (all dipoles) modes: TBN (70 kHz-bandwidth; continuous)

TBW (78 MHz-bandwidth, 61 ms burst)

Data are GPS Time Tagged (better than one part in 10¹¹)

LWA1 science emphasis: transients, pulsars, Sun, Jupiter & Ionosphere

Open skies – LWA is funded by NSF as a University Radio Observatory

Crab Giant Pulses

Flux densities 20-120 kJy Number of pulses/hour went up by factor 3 over 6 month period



Eftekhari et al. 2015

Crab Giant Pulses



Freq



Pulsars

Periodic sources, discovered at radio wavelengths by Bell in 1967. Now over 2000 known.

Extremely regular, most have $P \sim 0.001$ to 10 sec. Some are measured to ~15 significant figures and rival the best atomic clocks on earth.

They slow down, but very slowly:

for most.

Characteristic lifetime would correspond to $\sim 10^7$ years.

First explanation as NS by Pacini '67, Gold '68 (Gold predicted $\dot{P} > 0$)



Pulsar evolution

Since they slow down with age, they should lose energy to power the emission. Probably born with $P \sim$ several msec, die at \sim a few sec. Not clear how the emission mechanism turns off, but somehow associated with loss of rotational energy. Magnetic and electric fields may weaken, but highly uncertain.





Millisecond pulsars thought to be old neutron stars in binary systems. Many found in globular clusters.

Companion expanded, spills material onto slow neutron star.

When material reaches NS surface, it is orbiting very rapidly. As it accretes, it adds to angular momentum of NS, spinning it up again. 21

Typical Pulsar Observation with LWA1



LWA1 Pulsar Detections

B1133+16 J0030+0451 B0031-07 B1237+25 J0034-0534 J1327+34 B0138+59 B1508+55 J0203+70 B1540-06 B0320+39 B1541+09 B0329+54 B1604-00 B0355+54 B1612+07 B0450+55 B1642-03 B0525+21 B1706-16 B0531+21* B1749-28 B0628-28 B1822-09 B0655+64 B1839+56 B0809+74 B1842+14 B0818-13 B1919+21 B0823+26 B1929+10 B2020+28 B0834+06 B0919+06 B2110+27 B0943+10 J2145-0750 B2217+47 B0950+08 B1112+50 J2324-05

- >100 Pulsars detected (>94 through pulsations, 6 through single pulses)
- 6 MSPs detected
- Periods from 1.9ms to 4s



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Frequency Evolution









Pulsar Timing

Recently detected J0203+70 and J1327+34 are unpublished GBNCC (*Stovall et al. 2014*) discoveries, J2324-05 is an unpublished GBT350 (*Boyles et al. 2013*) discovery.

Timing Residuals: J1327+24 (DM 4.2 pc cm^-3; P=41.5 ms)



DM Monitoring



RRATs

Single pulse results for 'drx_56863_J2324-05'



