Radio Astronomy

HI Line – 21 cm Emission Matthew Rispoli



Why Radio Waves?

- Radio Waves are unaffected by the atmosphere.
- See "non-visible" astronomical objects
- Radio Telescope = Antenna



Ex: Radio Telescope



21 cm Emission

- Radio wave emission of neutral hydrogen
 - HI Line , $\lambda \sim 21 cm$
 - Resultant of hyperfine splitting in the ground state
- Protected wavelength
 - Can't use spectrum around 1420 MHz
 - 1400-1427 MHz
- Background should be limited
 - Doesn't happen very often... but there are *lots* of sources

21 cm Emission

- 1930's : "Hiss" from center of the galaxy
- 1944 : J.H. Oort and Hulst predicted a neutral hydrogen emission
- First detected by Ewen and Purcell in 1951
 - Neutral hydrogen helped map the spiral structure of the Milky Way

Hyperfine Splitting

- Fine Splitting
 - Spin-orbit interaction
- Hyperfine Splitting
 - Spin-spin interaction
- P-Dipole Moment $\mu_{\mathrm{I}} = g_{\mathrm{I}} \mu_{\mathrm{N}} \mathbf{I}$
- E-Dipole Moment ${oldsymbol{\mu}}_{
 m s}=-g_s\mu_{
 m B}{f s}$



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Use in Radio Astronomy

- Radio Astronomy
 - Spectrum for red shift
 - Galaxy Rotation
 - Which can be a form of standard ruler



- Gas Clouds
 - (what is the most abundant thing in the universe?)

Use in Radio Astronomy

- Experimental Aside
 - Galaxy Rotation ir Milky Way
 - Remember you measure a chord through the galact plane
 - Radiation from 21 cm will seem smeared from changes in red shi



Pretty Pictures



Cosmology

- High Z -large red shift-
 - Ways to probe "dark ages
 - Problems with high Z 21 cm... it's no longer 21 cm
 - Background problem
 - Used for measuring recombination and ionization

My EE Thesis?

- Use patch antennas
 - Benefits: **cheap**, easily assembled, great for arrays, no moving parts
 - Fairly narrow band, not very directive, or the best efficiency
 - But this can be fixed with arrays
- Use evolutionary algorithms to design them!
- Get Farley and Kehoe to actually build and use the thing

VLA



Questions?