HI DATA AND ANALYSIS TOOLS

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FEATURING JORDAN LASUIK

HI Data and Analysis Tools

- Review: HI 21cm Line Generation
- Signal Detection
- Signal Processing
- Data
- Dynamical Mass
- References

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HI 21cm Line Generation

- Cool HI gas emits at radio wavelengths
- Radio waves can penetrate the dusty disk of a galaxy
- Observing spectral lines allows calculation of gas velocity

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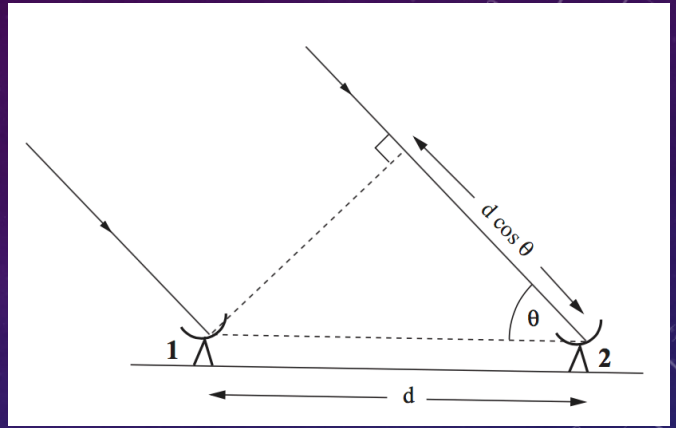
Signal Detection – The Basics

- Signals are detected using radio telescopes
- Single telescope or array of multiple antennas
- One dish results in a global HI intensity profile
- An array (interferometer) results in much higher resolution

John A. Galt Telescope at DRAO

Signal Detection – Architecture

- More antennas = better coverage
- Resolution is directly correlated to baseline length
- Array layout determines coverage pattern
- Straight line array allows full coverage in a 12hr period



2-antenna interferometer [S&G pg. 207]

VLA in New Mexico

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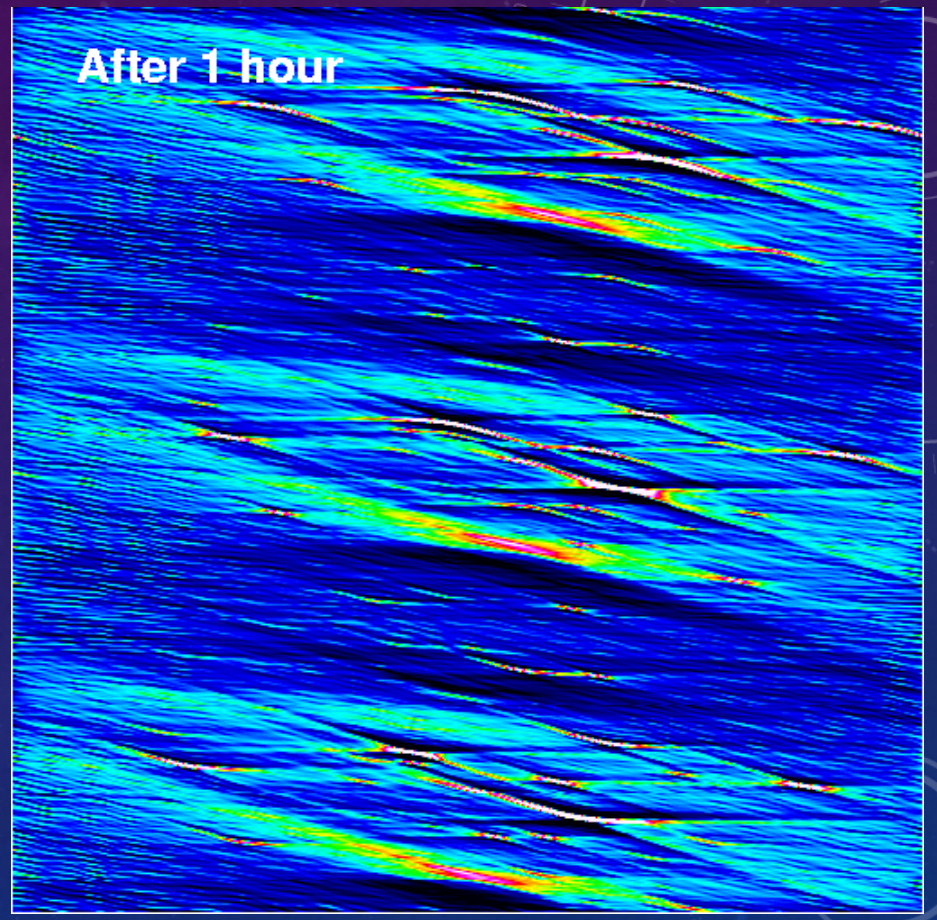
Signal Processing

- Signal from the antennas is processed in a correlator
- The interference fringes are fourier transformed onto the plane of the sky
- Take the Radio Astronomy course for more



Assembling radio synthesis data

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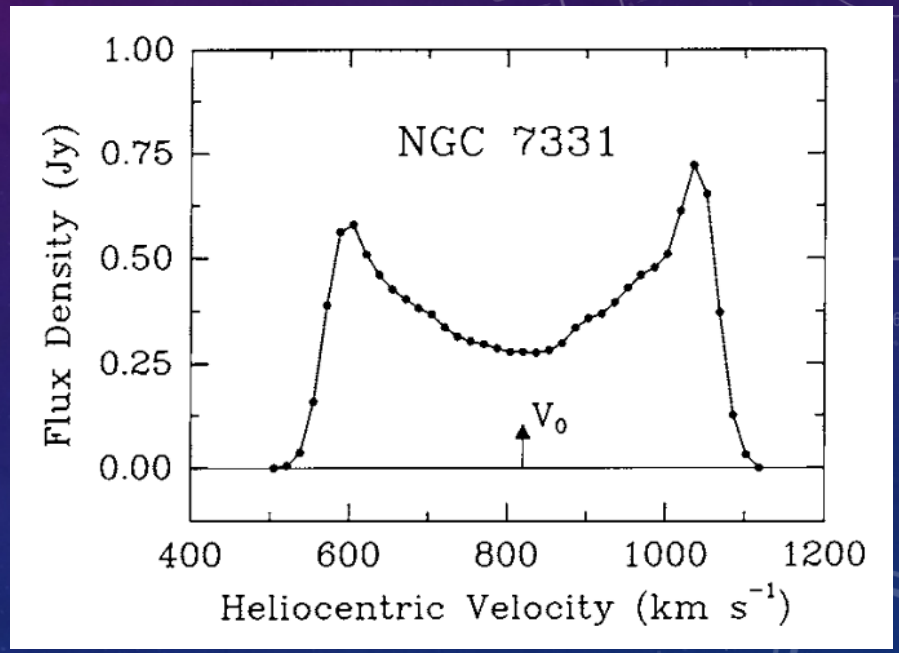
Data – Hardware Matters!

- Single dish catches all signal from the target
- This gives a global HI intensity profile (Double Horn)

- Array (interferometer) gives a much higher resolution
- ‘Full Synthesis’ interferometer is best



Double Horn global HI profile for NGC 7331 [S&G pg. 220]

Data – Putting It All Together

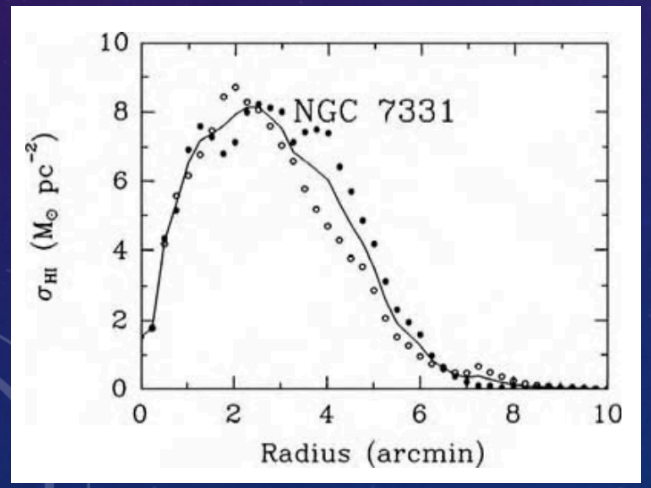
- Each channel of data results in a Channel Map

- We can combine these Channel Maps to get more maps
  - Moment Maps
  - Velocity Field Maps
  - Position-Velocity diagram

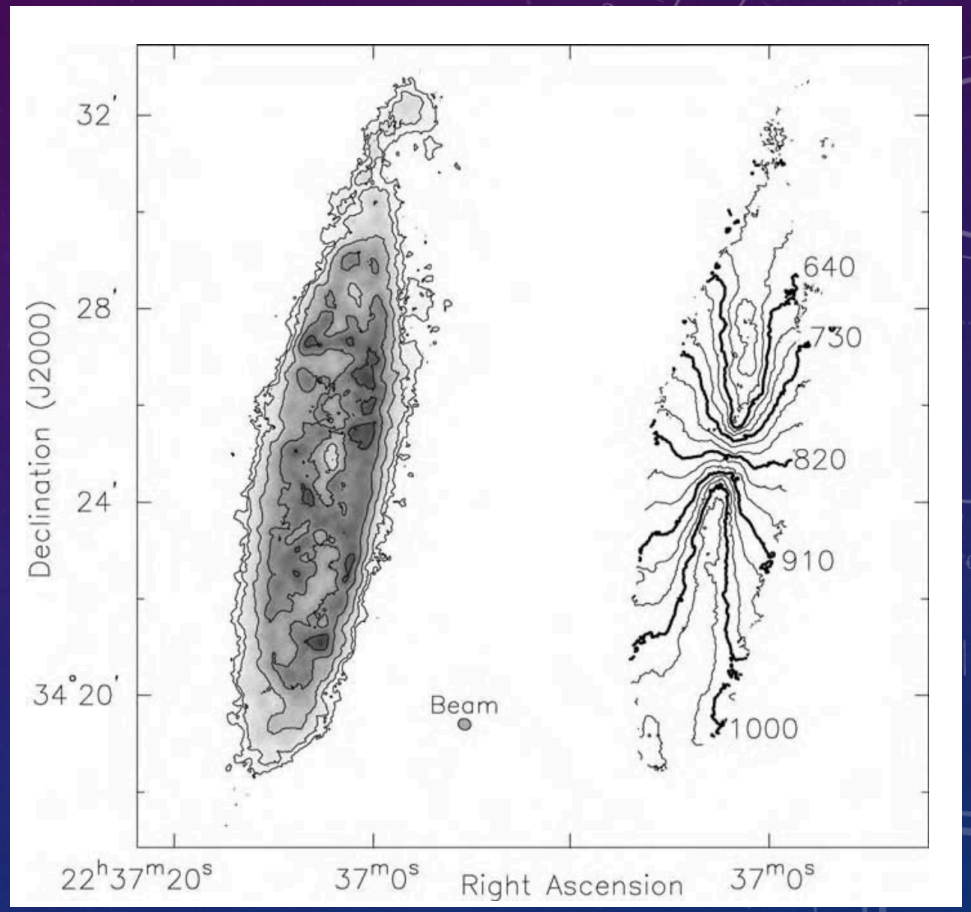
(Prof's note: Examples were given on data of NGC 3198 using the KARMA visualization suite.)

Data – Moment Maps

- 'Moment Zero' Map gives N_{HI} (column density)
- Summing globally gives gas mass
- We also get density vs. radius



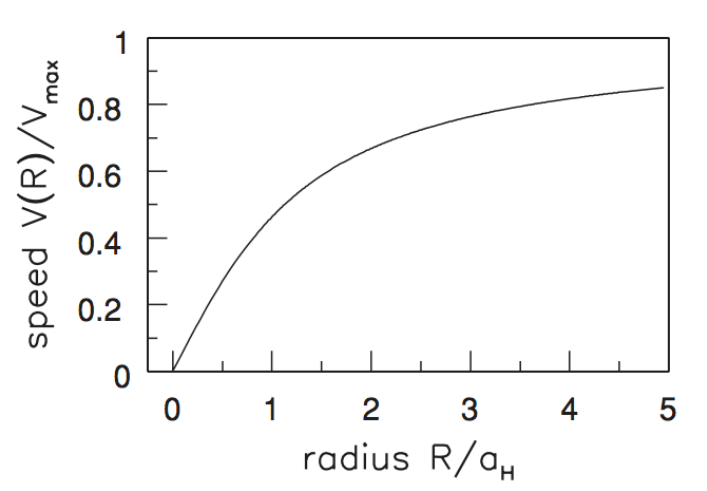
Density vs. radius
[S&G pg. 211



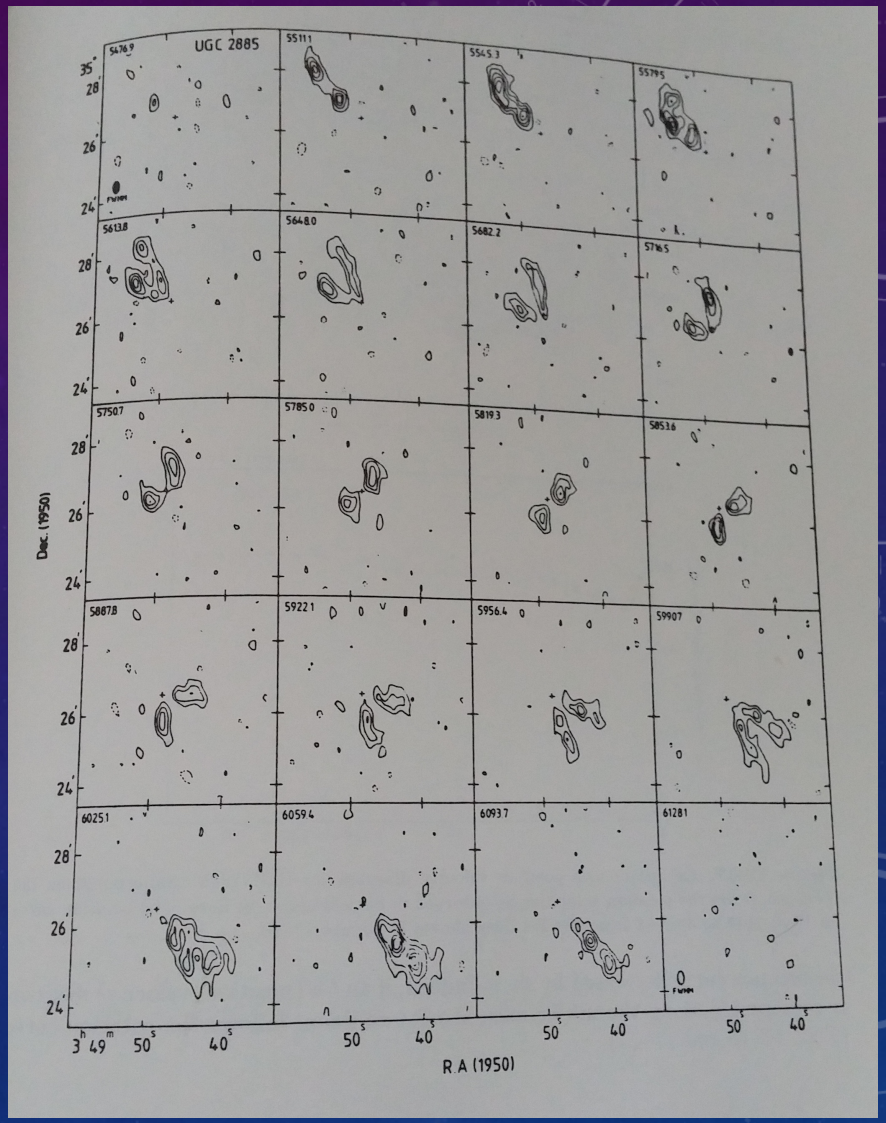
NGC 7331 Moment zero map (left) and velocity field map (right) – Data from VLA [S&G pg. 210]

Data – Velocity Field Maps

- ‘First Moment’ Map gives gas velocity
- From this we can get the rotation
- Results in ‘butterfly’ pattern channel maps



Example rotation curve based on velocity profile [S&G pg. 216]



Velocity field channel maps of UGC 2885 [Van Gorkom & Ekers pg. 337]

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Dynamical Mass

- Do we really need a slide for this?

$$\frac{V^2(R)}{R} = \frac{G\mathcal{M}(<R)}{R^2}$$

Dynamical Mass equation
[S&G pg. 215]

Dynamical Mass

- Do we really need a slide for this?

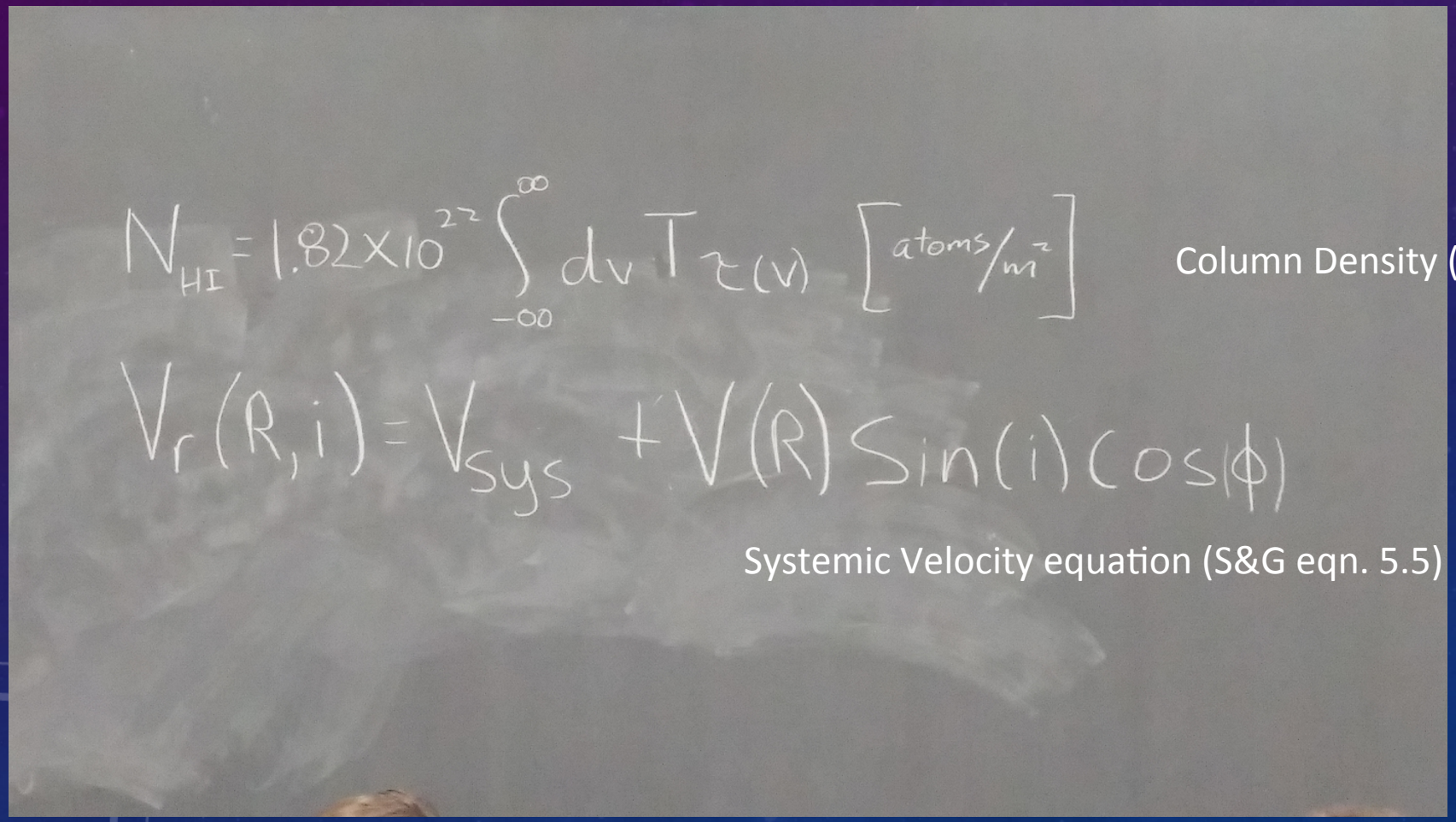
$$\frac{V^2(R)}{R} = \frac{G\mathcal{M}(<R)}{R^2}$$

Dynamical Mass equation
[S&G pg. 215]

References – “I Would Like to Thank the Academy…”

- Galaxies in the Universe: An Introduction 2ed. (Sparke & Gallagher)
- Synthesis Imaging in Radio Astronomy (Van Gorkom & Ekers)
- Galactic Astronomy: Structure and Kinematics (Mihalas & Binney)
- Essential Radio Astronomy (Condon & Ransom)
- ALMA website: alma.mtk.nao.ac.jp/e/index.html
- DRAO website: www.nrc-cnrc.gc.ca/eng/solutions/facilities/drao.html
- NRAO website: public.nrao.edu
- NED Level 5: ned.ipac.caltech.edu/level5/
- Some Grumpy Cat picture from a Google search
- Dr. English

~~Bored~~ Board Equations…



Column Density (From Jordan's presentation)

Systemic Velocity equation (S&G eqn. 5.5)

(Prof's note: N_HI can be converted to hydrogen gas mass. See previous lecture.)

Craft Time!

Congratulations to Wolfgang who actually finished his! The extra decorations are in OPUS if anyone would like to bedazzle their antenna.