The HI Mass Function: Open Questions

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The Evolution of Galaxies through the Neutral Hydrogen Window
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HI Mass Functions

Is There One HI Mass Function?

Is a Schechter Function best fit?

Is the bright end variable?

$\alpha = -1.5$

$\alpha = -1.2$
The Schechter Function

- If $\alpha = -1$, high mass objects are main contributors.
- If $\alpha = -2$, logarithmic divergence at low masses.
- Is dynamical mass function steeper than HIMF? Do low-mass objects have bigger $M/L$?
Lessons

- Early surveys had small numbers, but were deeper than current surveys.
- Nearby was outskirts of Local Supercluster, distant was dominated by Pisces-Perseus.
- Also face flux-bias problems when hunting close to noise: promote more weak sources than lose stronger sources.
The slope is relatively flat for the first 142 galaxies detected. (Auld 2007)
How does HIMF evolve as density climbs?
• Zwaan et al. 2005 argue against variance based on nearest neighbor among HIPASS galaxies.

• …but Meyer et al. 2007 find that HI-rich galaxies are among least clustered objects.
Galaxies selected within the redshift range of the cluster do not look at all clustered (Cortese 2007)
Mass vs. Distance for ALFALFA and AGES

Zwaan noted that despite numbers in HIPASS, it “touched” a much smaller volume than early surveys for low-mass sources.

\[ V_{\text{SC}} = \text{volume of supercluster with 20 Mpc radius} \]

\[ V_{\text{SC}} \times \]
Testing detection rates in AGES Cubes

• We have built routines to insert simulated sources into the raw data.

• The sources undergo all of the processing (baseline fitting, etc.) that real signals do.

• In a previously studied cube, two people searched the cube as did a computer program.

• We can begin to characterize completeness and reliability.
Simulations: initial stats

- From the list of detected sources, we searched for matches with the simulated sources by position and velocity.
- Of 400 sources added, 162 were recovered by 1 or more of the searches, while 87 spurious detections were recorded.
  - 3 detections: 110 sources (+5% spurious)
  - 2 detections: 29 sources (+13% spurious)
  - 1 detection: 23 sources (+340% spurious)
- A typical detector recovered 85% of the sources that anyone else found, and added 20% spurious sources.
- Two passes seems to result in fairly good
• The chance of detecting a source depends on its line width.
• The same mass of HI is easier to detect when the signal is “tall” and narrow.
• Some algorithms select primarily by flux density.
• Others by smoothing and testing.
• Results usually fall in between $W^{-1}$ and $W^{-1/2}$. 
• Also find a roll-off in completeness.

• Completeness depends on line width and shape.

• Conservative estimates of sensitivity ↔ steeper slope for HI Mass
Next Steps: Weak Sources in the Noise

Distribution of noise in an interference-free portion of the bandpass shows an excess that may be produced by faint undetected HI sources.

\[ \sigma = 0.98 \]
Thoughts about Digging in the Noise

We need to examine narrow range of redshifts to interpret masses of faint sources.

- Limiting mass goes as $D^2$ so need to do this nearby to get low masses.
- We can maybe get down to the 3σ level so maybe say something statistical about sources at distances 50% farther away.
- Distance range should probably be < +/- 10% of distance so masses remain within about factor of $(1.10/0.9)^2 = 1.49$
Problems of Interpreting Noise Stats

Massive sources contribute to low-mass signal.

- Face-on has a strong signal in a few channels, but galaxies more likely to be edge-on spread over many channels and be weak in each.

- By selecting a narrow redshift range (about width of low-mass sources), low mass sources will dominate by > their number counts.

- Are there ranges of distance in which we are complete for wide sources (because there are many channels) where we can still