



International
Centre for
Radio
Astronomy
Research

HI Stacking and the Tully-Fisher Relation

Scott Meyer

Supervisors: Martin Meyer, Danail Obreschkow and
Lister Staveley-Smith



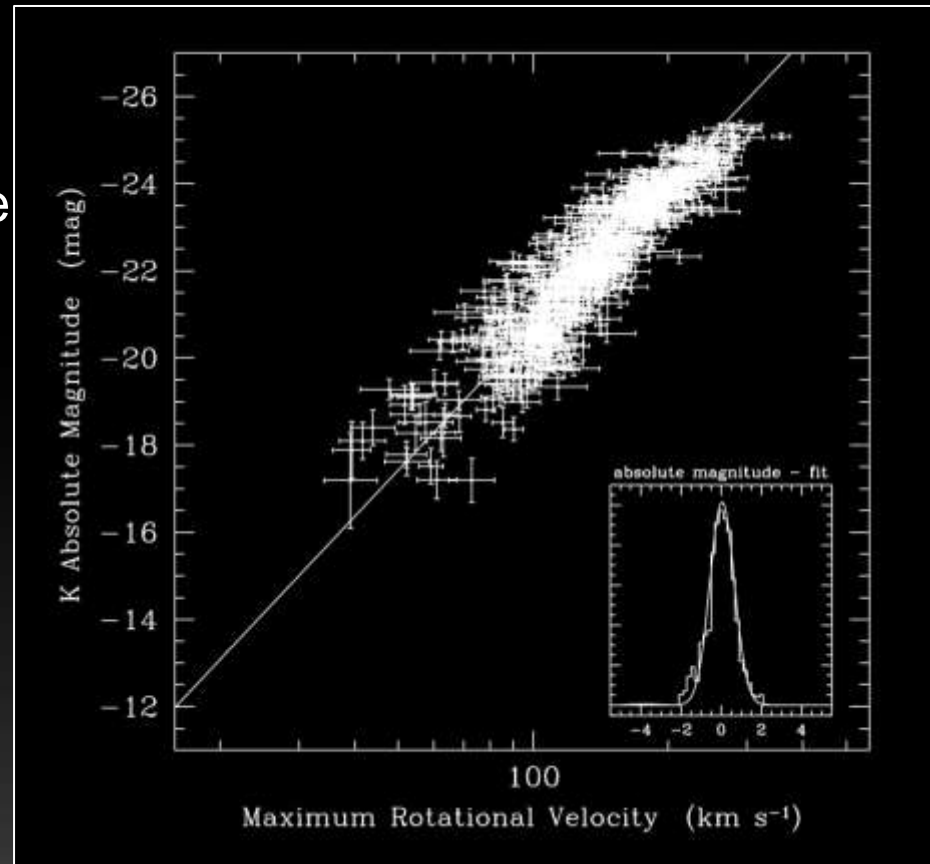
THE UNIVERSITY OF
WESTERN AUSTRALIA
Achieve International Excellence

Outline

- **What is HI stacking?** What is the **Tully-Fisher Relation?**
- **What can we do** with HI stacking and the Tully-Fisher Relation?
- **Analytical** galaxies
- **Simulated** galaxies

What is the Tully-Fisher relation?

- Empirical relation between **luminosity** and **maximum rotation velocity** of late type spiral galaxies (Tully & Fisher 1977)
- Used to constrain simulations
- Historically used to measure distances

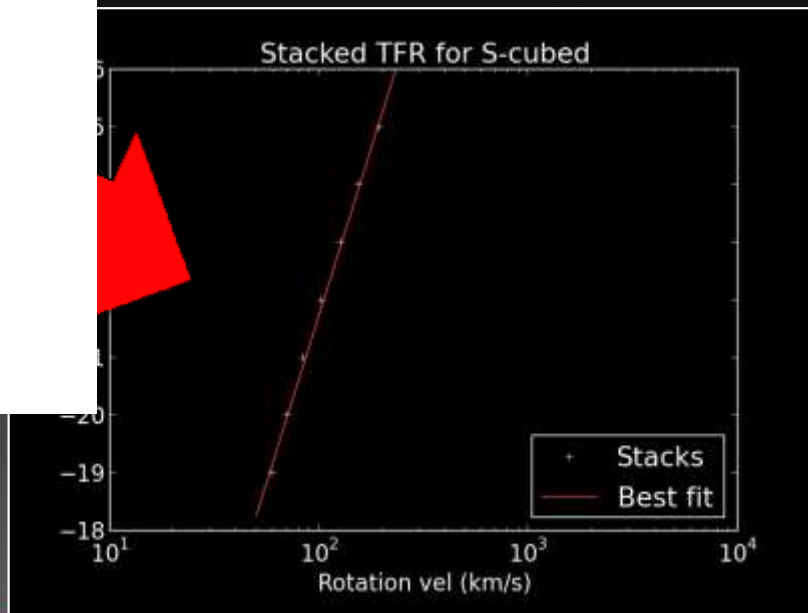
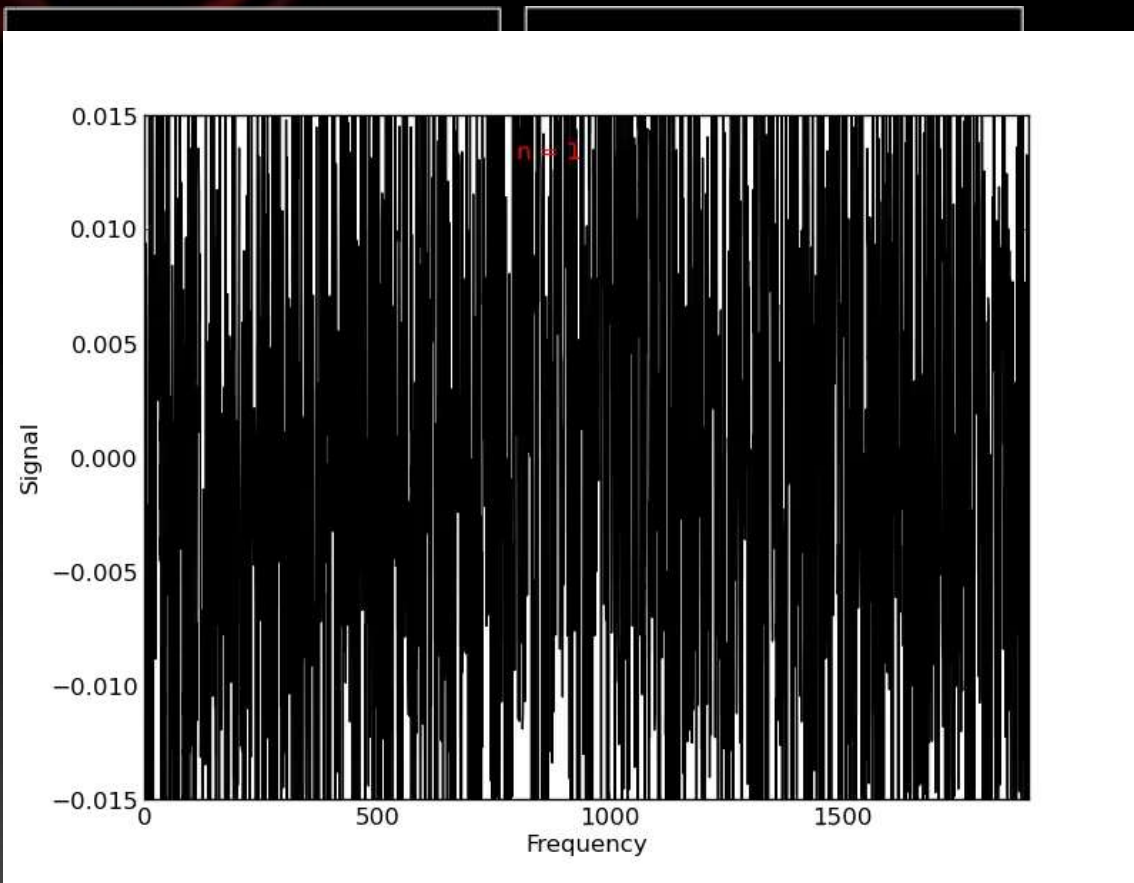


Meyer, M. J., Zwaan, M. a., Webster, R. L., Schneider, S. E., & Staveley-Smith, L. (2008). Tully-Fisher relations from an HI-selected sample. *Monthly Notices of the Royal Astronomical Society*, 391(4), 1712–1728. doi:10.1111/j.1365-2966.2008.13424.x



How can HI Stacking be used to define the Tully-Fisher relation?

Stack galaxies and then measure w_{50} or w_{20} .

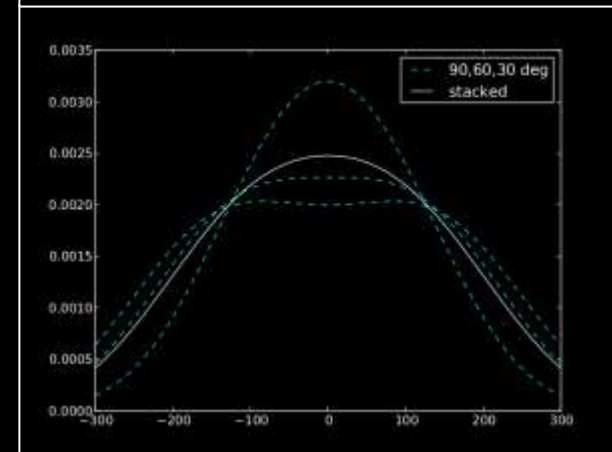
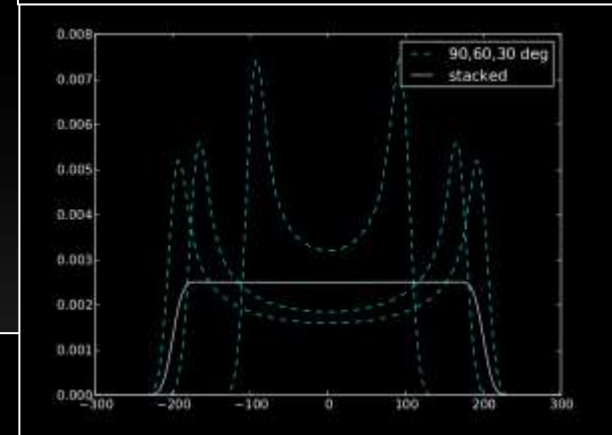
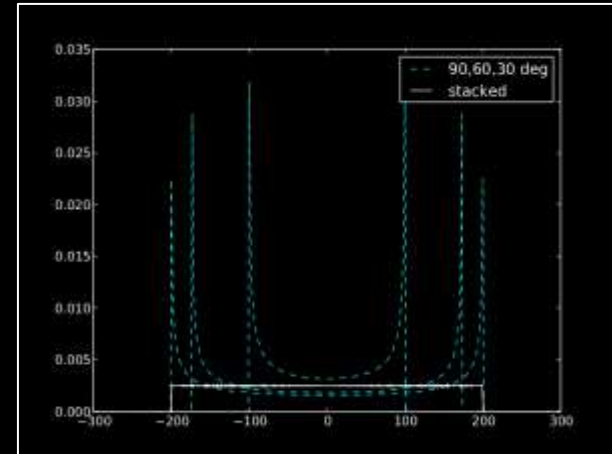
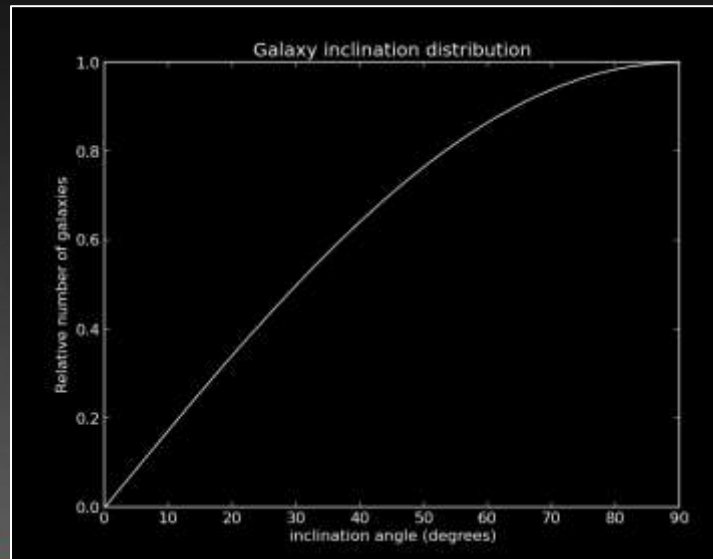


Why would we want to do this?

- Reduce **inclination errors**
- Improve **signal to noise** ratios
- Derive a relation for **higher redshift**
- To allow contributions from **confused sources**
- To reduce **bias** in data samples

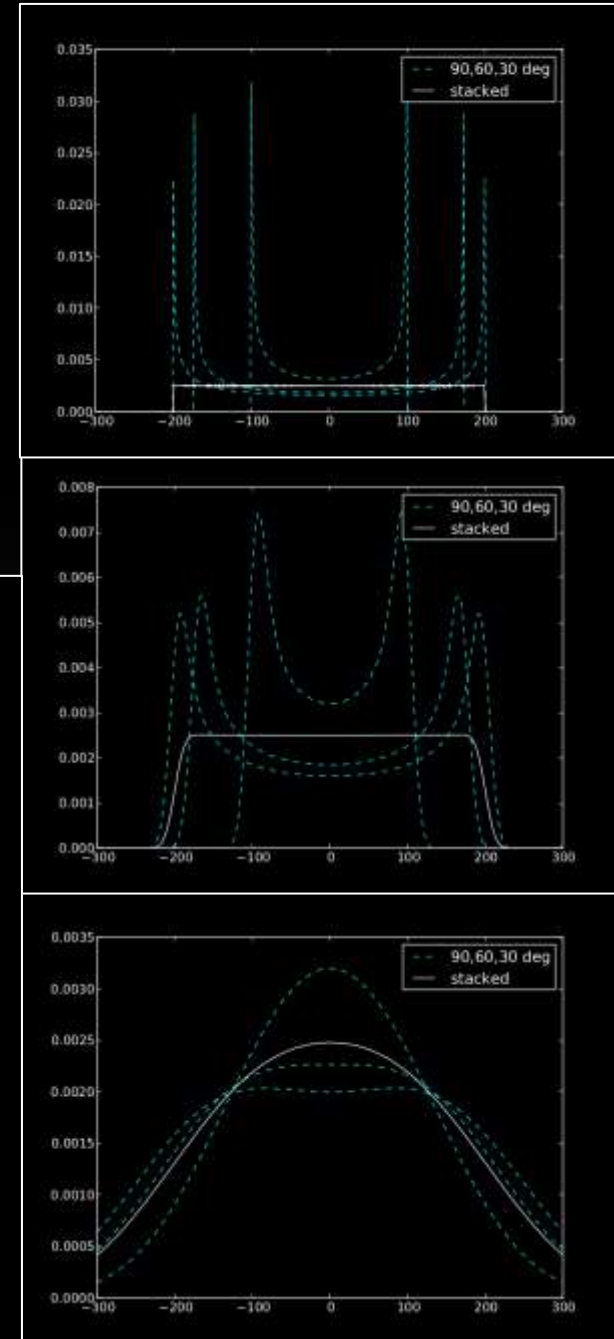
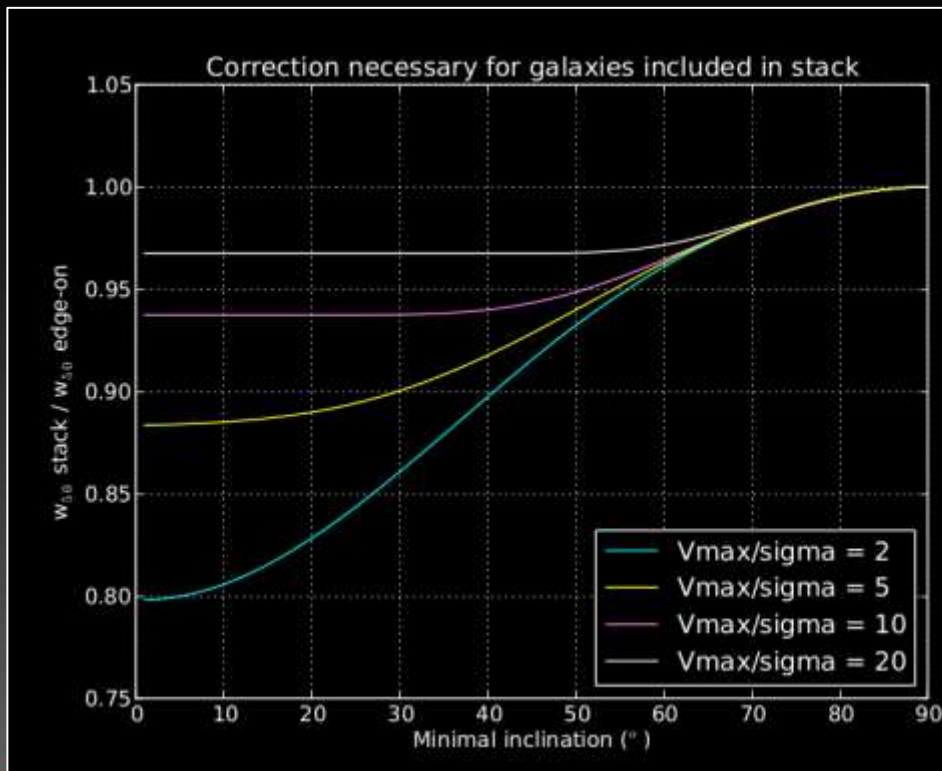
An analytical look

- **Modelled galaxies** as solid rotators
- ‘One’ galaxy spectrum produced, changed in inclination only
- **Dispersion** added
- **Weighted by $\sin i$** to mimic inclination distribution observed in the Universe



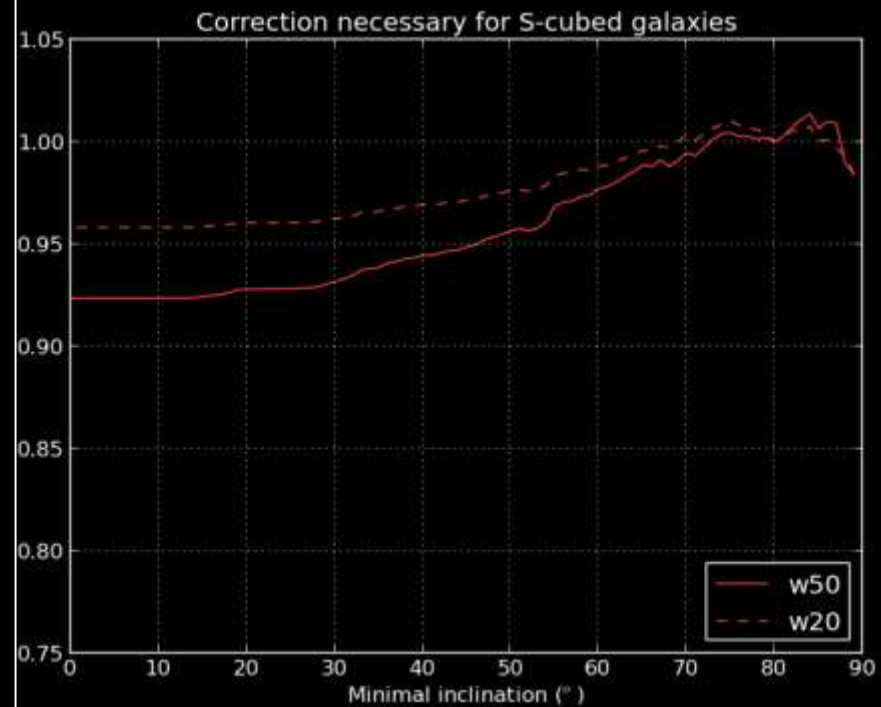
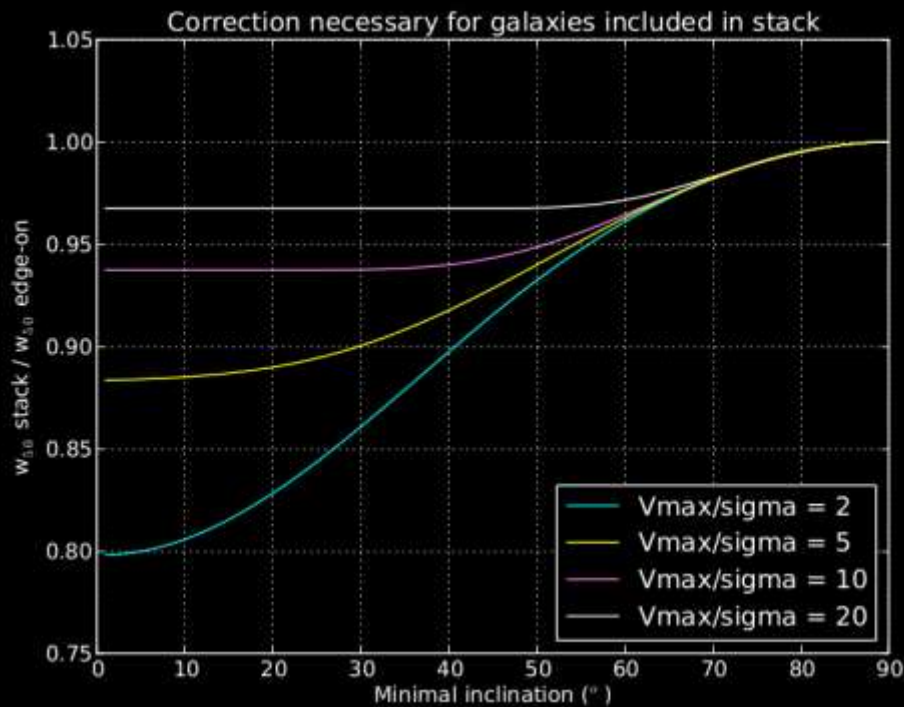
An analytical look

- How much do the stacked widths differ from the width of the individual galaxies corrected for inclination?



From Simulations (S-cubed)

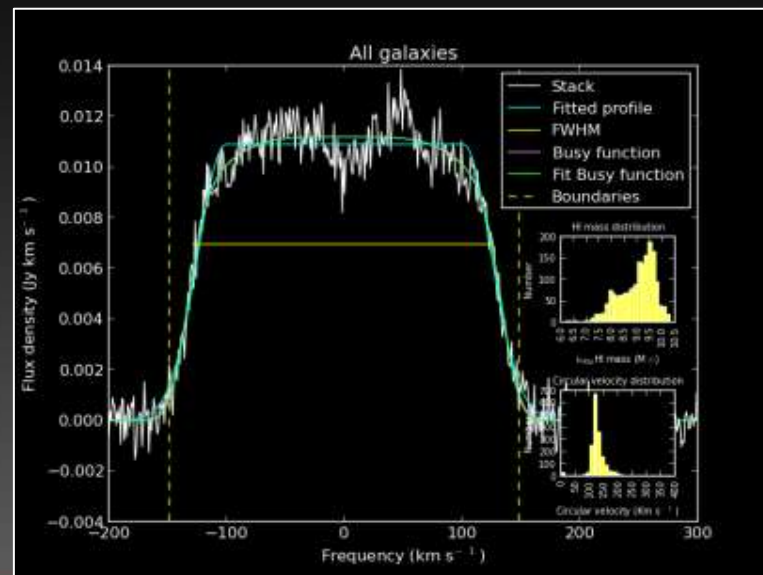
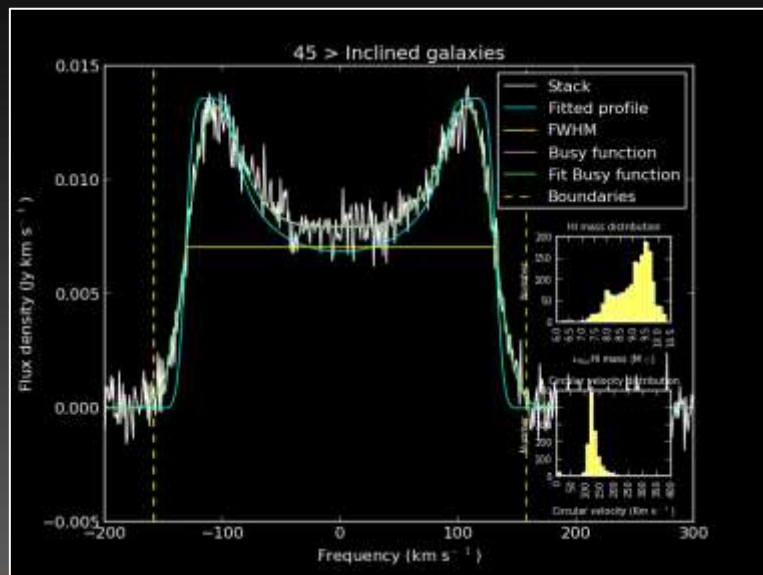
- Galaxy samples were taken from the S-cubed database so we could work with **larger samples** with **more realistic** properties





Simulation: Fitting functions

- **Fitted function** (The equivalent analytical expression)
- **FWHM** (simple, doesn't perform well for low S/N)
- **Busy function** (Westmeier et al. in prep, mimics HI profiles, also appears to fit HI stacked profiles well)
- **Fitted Busy function** (Less parameters so shape doesn't change)



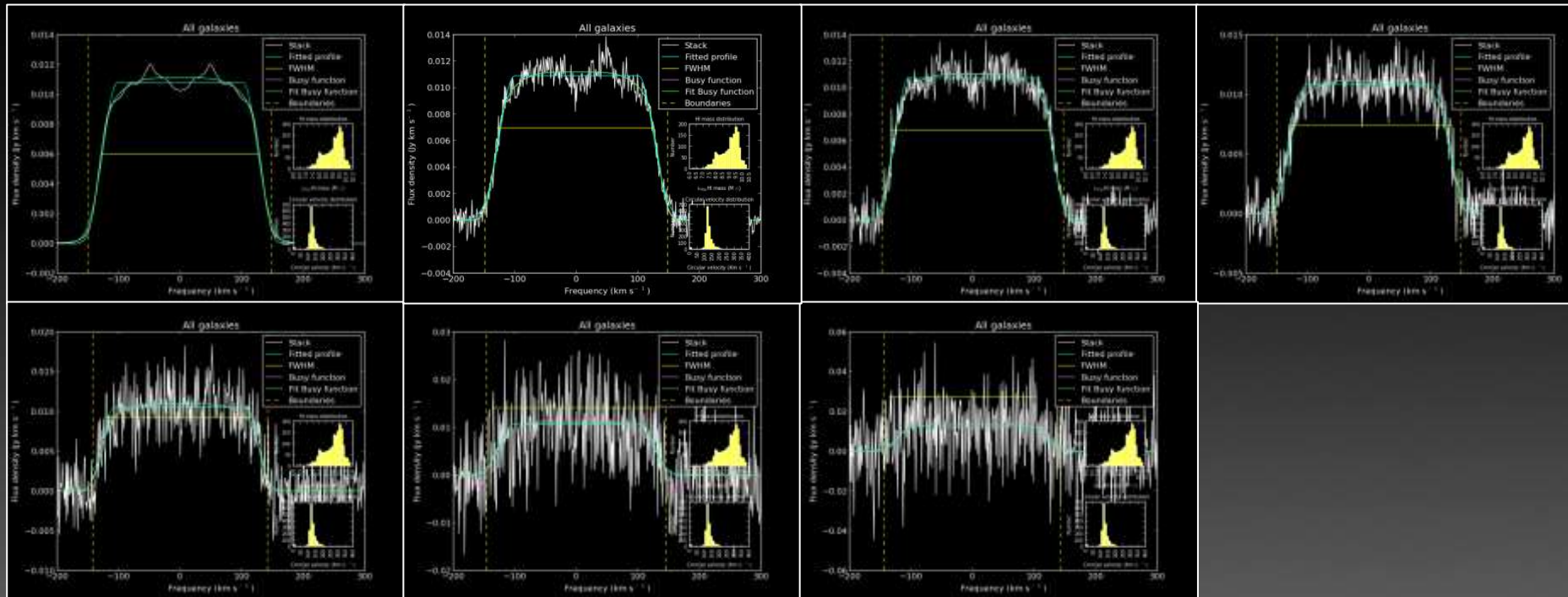


Simulation: Noise considerations

- Noise artificially injected after stacking (as pre-stacking was too computationally expensive) using equation:

$$\frac{S}{N_{\text{total}}} = \frac{S}{\sigma_{\text{chan}} \Delta v_{\text{chan}} \sqrt{N_{\text{chan}}}}$$

- Each fitting function tested with varying levels of noise

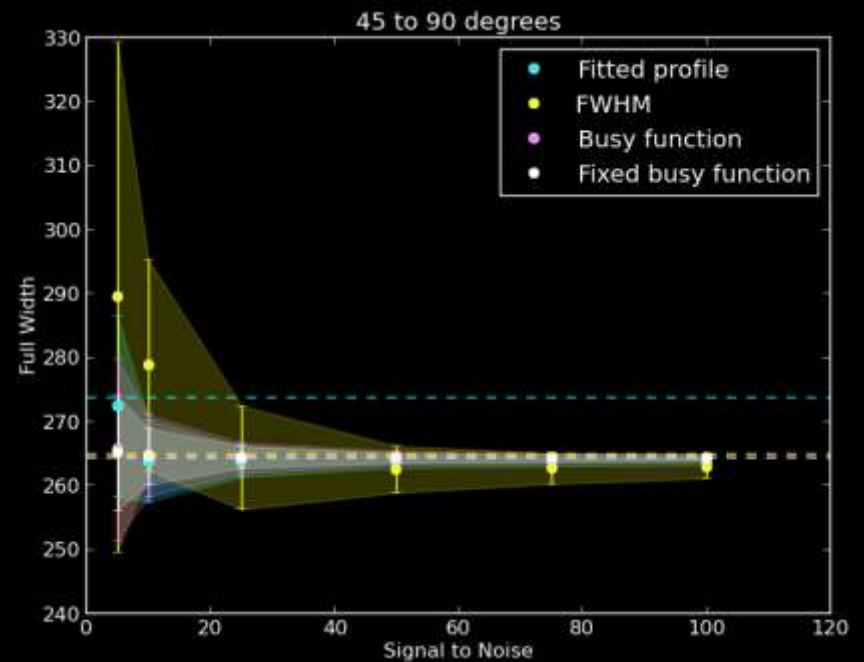
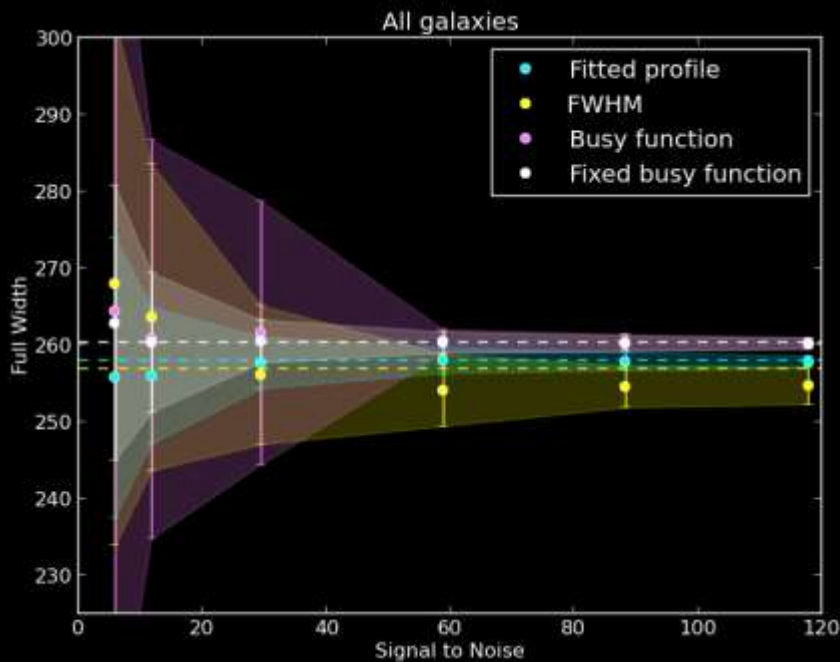


Simulation: Noise considerations

- Noise artificially injected after stacking (as pre-stacking was too computationally expensive) using equation:

$$\frac{S}{N_{\text{total}}} = \frac{S}{\sigma_{\text{chan}} \Delta v_{\text{chan}} \sqrt{N_{\text{chan}}}}$$

- Each fitting function tested with varying levels of noise



Simulation: Stacked vs non-stacked Tully-Fisher relation

- **Stacking** S-cubed galaxies **reproduces** the same **slope**
- **Correcting** for width 'lost' by stacking **reproduces** **intercept**

