# HI (21cm) Single Dish Observations of Galaxies: Modeling the HI Global Profile

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## The HI Global Profile

- The HI global profile is the observation result of galaxies in the 21cm wavelength, which is HI line flux plotted as a function of radial velocity.
- The HI emission line is the emitted caused by neutral hydrogen (HI) spin-flip (hyperfine) transition, having a frequency of 1420.4 MHz and a wavelength of 21cm.

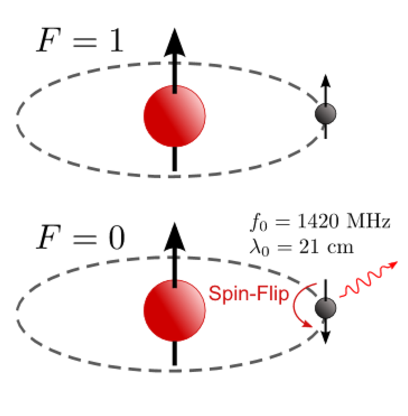


Fig.1-Hyperfine transition of neutral hydrogen.

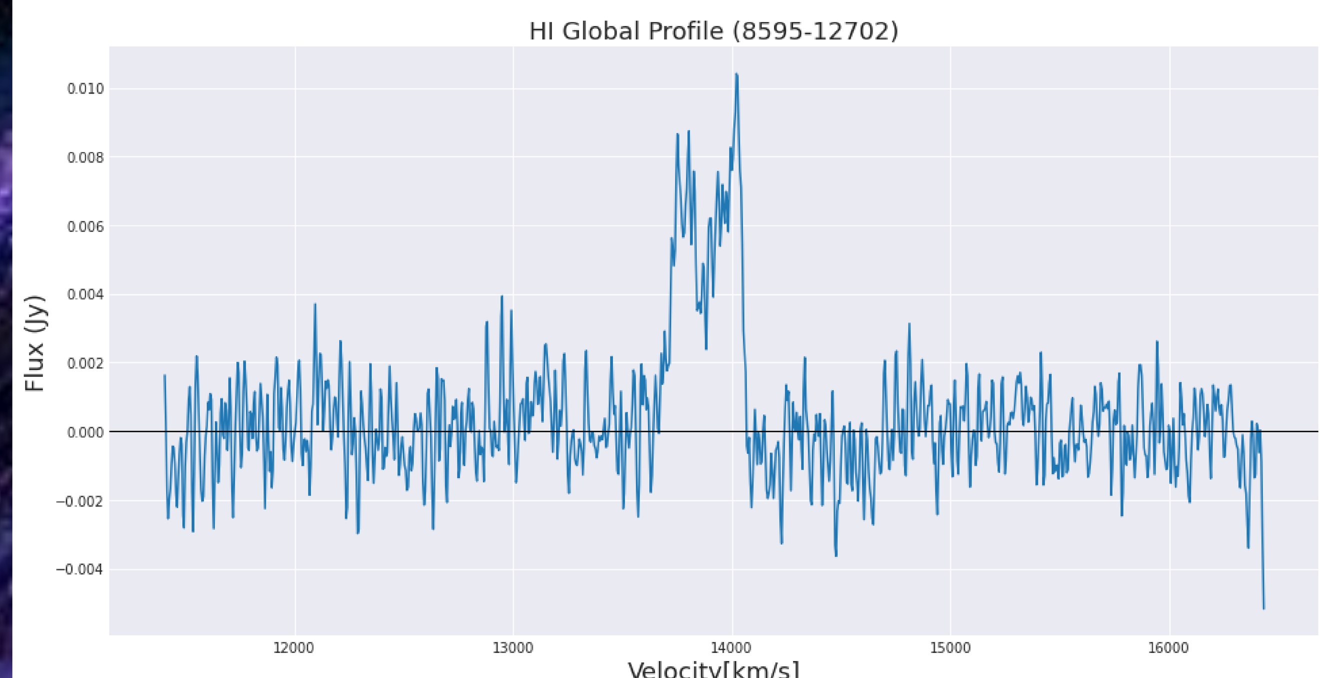


Fig2-HI global profile of MaNGA galaxy 8595-12702.

The key features of a HI global profile include:
- Double-horn shape, caused by galaxies being a rotating point source for single dish radio telescopes.
- Asymmetry, caused by galaxy kinematics and the HI location asymmetry.

## Data

- **SDSS-IV MaNGA** Survey data release 17 (Bundy et al. 2015).
- **Hi-MaNGA** survey data release 2 (Masters et al. 2019).
- The software **Marvin** has been used to import and analyze the data (Cherinka et al. 2019).
- Handpicked MaNGA galaxy **8595-12702** as targeted galaxy.

## Methods to obtain HI Global Profile

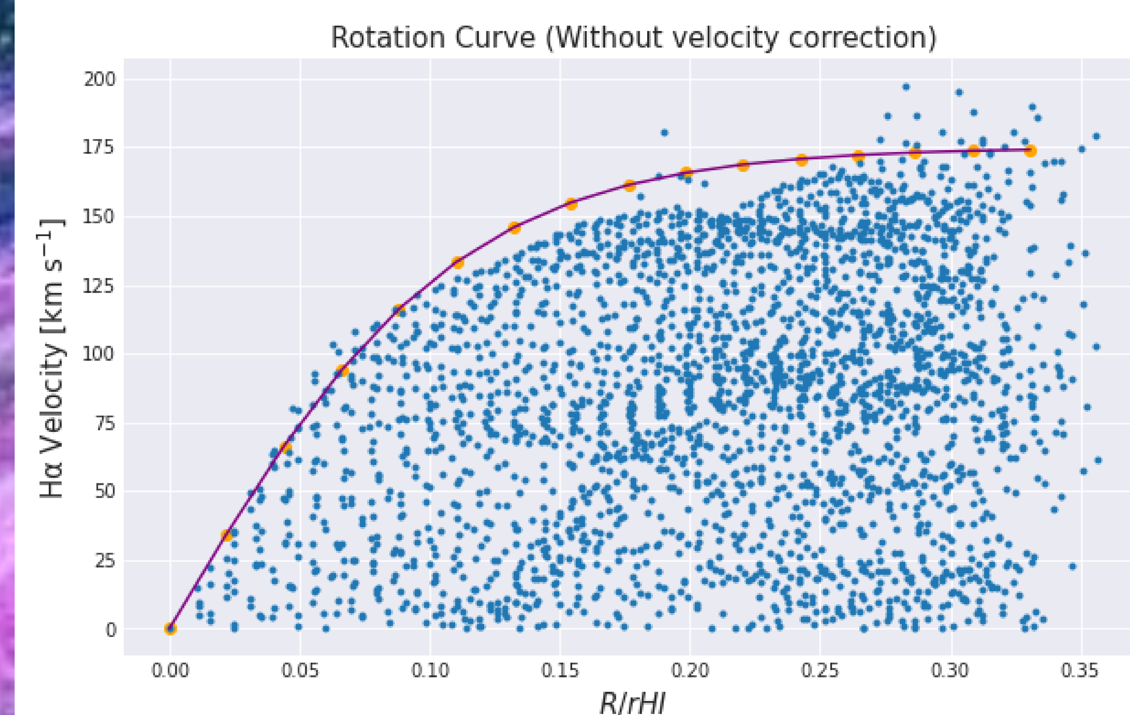


Fig.4-Rotation curve model based on Yoon et al (2021).

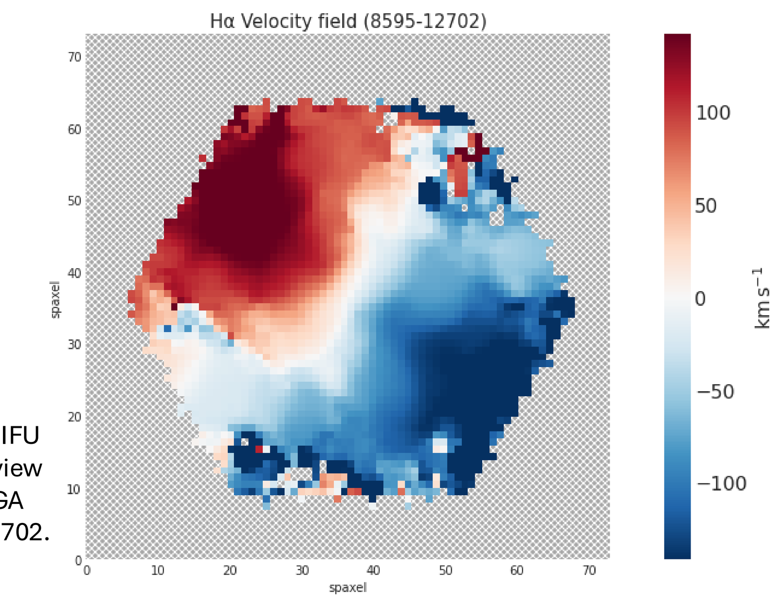


Fig.3-MaNGA IFU field of view of MaNGA 8595-12702.

### Rotation Curve Model

- HI radial velocity as a function of radius.
- Obtained from extracting the MaNGA IFU field of $H\alpha$ velocity.
- Model to fit the extracted line-of-sight velocity map (Yoon et al. 2021):

$$V(r) = V_c \tanh\left(\frac{r}{R_t}\right) + S_{out} r$$

### Radial Profile Model

- HI Surface density as a function of radius.
- Based on "Model 0" presented in Stevens et al. (2019):

$$\Sigma_{HI}(r) = \Sigma_0 \exp\left(-\frac{r}{r_s}\right)$$

- Discretized "Model 0" to account in the effects of center HI distribution.

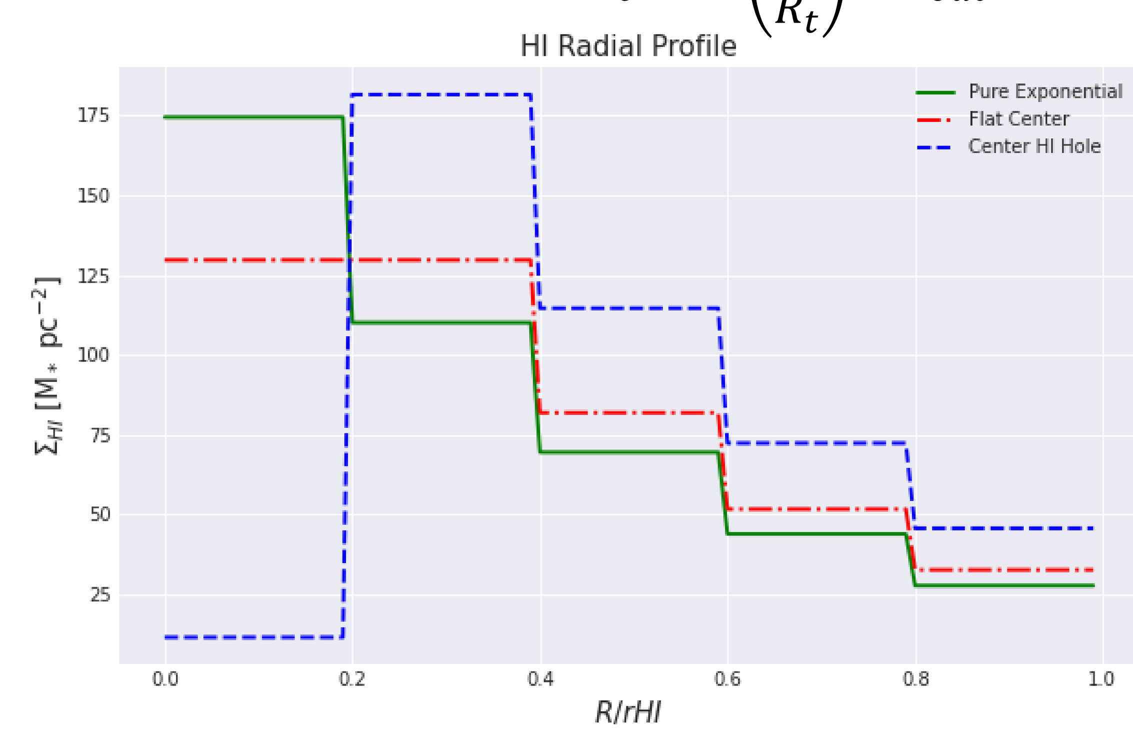


Fig.5-Discretized HI radial profile models after scaling based on "Model 0". The graph shows the model of pure exponential disc (green), flat center disc (dash-dotted red), and existence of center HI hole (dashed blue).

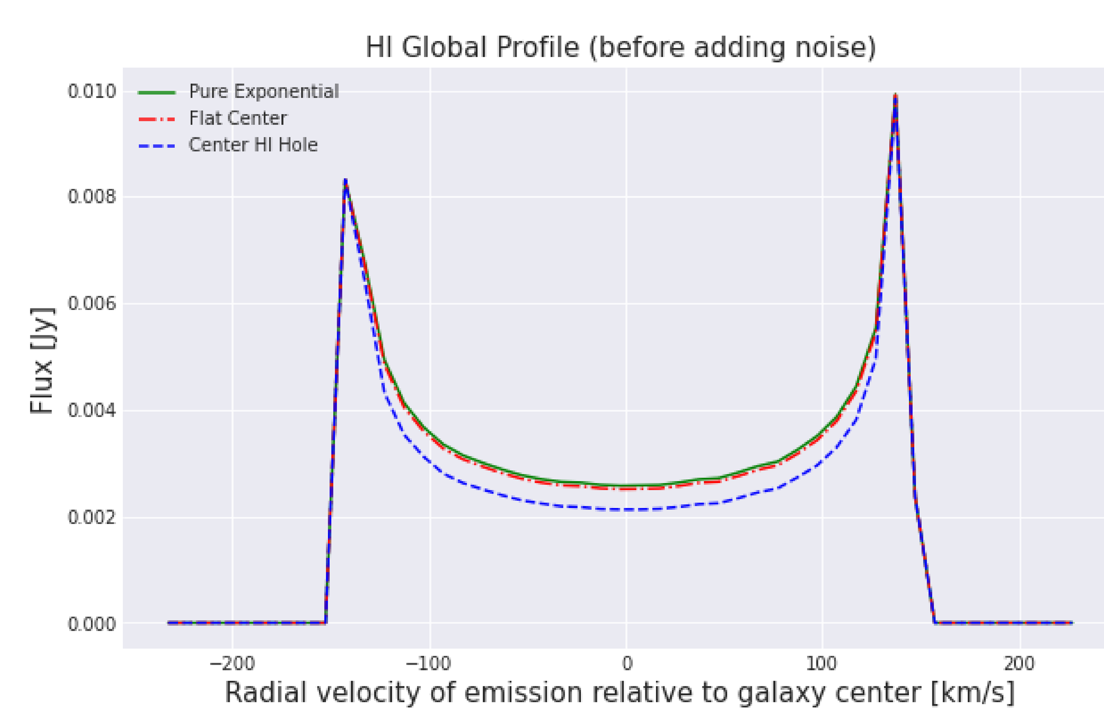


Fig.6-Calculated HI global profile of MaNGA galaxy 8595-12702 according to different radial profile models.

### HI Global Profile

- The final HI global profile model is obtained by combining the Rotation Curve Model and the Radial Profile Model.
- Integrate the surface density at a certain radii to obtain line mass.

## Results

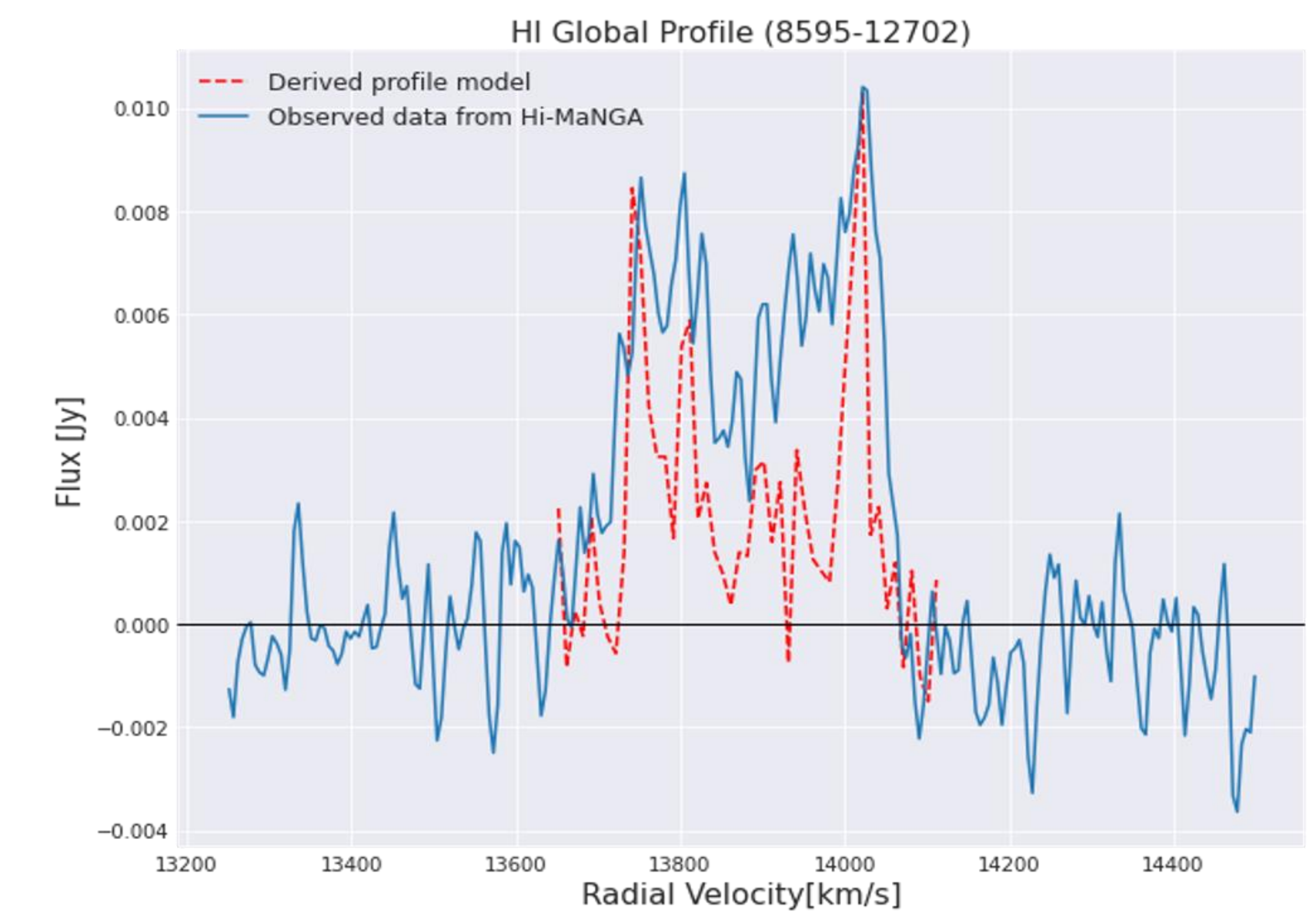


Fig.7-The model global profile after adding noise (in dashed red) and the actual observed data of galaxy 8595-12702 from Hi-MaNGA (in blue).

**Successful in:**
- Reproducing the asymmetric double-horn shape of the global profile.
- Capturing the correct flux range in which the profile exists.

**Fails in:**
- Struggles to reproduce FWHM accurately - will improve in future by using HI observed width to constrain RC.
- The peak and center values are not yet fit to the data, currently use reasonable guess for the best radial profile model. Future work will be to optimize this to fit data.

## Conclusion

- Demonstrated a method for reconstructing the HI global profile by combining RC and HI radial profile.
- Captured key features of the observed profile of MaNGA 8595-12702
- Future work will include refinements using more accurate input from the rotation curve and radial profile model to work to find best fit to the data.

## Acknowledgments

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