

1. What a Luminosity Function (LF) Is

The luminosity function (LF) tells you how many galaxies exist per unit volume per unit magnitude:

$$\Phi(M) = \text{number density of galaxies at magnitude } M$$

Units are usually $\text{Mpc}^{-3} \text{mag}^{-1}$.

Using the **1/V_{max} method**, the LF is computed as:

$$\Phi(M) = \frac{1}{\Delta M} \sum_{i \in \text{bin}} \frac{1}{V_{\text{max},i}}$$

where each galaxy contributes $1/V_{\text{max},i}$ to the bin it falls in.

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2. Poisson Errors in the LF

Poisson error quantifies the uncertainty in the LF due to finite galaxy counts in each magnitude bin:

$$\sigma_{\Phi}(M) = \frac{1}{\Delta M} \sqrt{\sum_{i \in \text{bin}} \left(\frac{1}{V_{\text{max},i}} \right)^2}$$

- If many galaxies fall in a bin, the Poisson error is smaller. - If few galaxies fall in a bin, the error is larger — indicating the LF is less certain in that magnitude range.