Salpeter Mass Function

The Initial Mass Function for stars in the Solar neighborhood was determined by Salpeter in 1955. He obtained:

$$\xi(M) = \xi_0 M^{-2.35}$$ **Salpeter IMF**

ξ_0: constant which sets the local stellar density

Using the definition of the IMF, the number of stars that form with masses between M and M + ΔM is: $\xi(M)\Delta M$

To determine the total number of stars formed with masses between M_1 and M_2, integrate the IMF between these limits:

$$N = \int_{M_1}^{M_2} \xi(M)\,dM = \xi_0 \int_{M_1}^{M_2} M^{-2.35}\,dM$$

$$= \xi_0 \left[\frac{M^{-1.35}}{-1.35} \right]_{M_1}^{M_2} = \frac{\xi_0}{1.35}\left[M_1^{-1.35} - M_2^{-1.35} \right]$$

Can similarly work out the total **mass** in stars born with mass $M_1 < M < M_2$:

$$M_* = \int_{M_1}^{M_2} M\,\phi(M)\,dM$$

Properties of the Salpeter IMF:

- most of the stars (by number) are low mass stars
- most of the **mass** in stars resides in low mass stars
- following a burst of star formation, most of the **luminosity** comes from high mass stars

Salpeter IMF must fail at low masses, since if we extrapolate to arbitrarily low masses the total mass in stars tends to infinity!

Observations suggest that the Salpeter form is valid for roughly $M > 0.5\ M_{sun}$, and that the IMF `flattens' at lower masses. The exact form of the low mass IMF remains uncertain.

Comments on the Salpeter IMF

What is the origin of the IMF?

Most important unsolved problem in star formation. Many theories but no consensus.

Observationally, known that dense cores in molecular clouds have a power-law mass function rather similar to the IMF. So the IMF may be determined in part by how such cores form from turbulent molecular gas.

Is the IMF `universal'?

i.e. is ξ(M) the **same function** everywhere?

Most theorists say no. Predict that fragmentation is easier if the gas can cool, so primordial gas without any metals should form more massive stars.

Observationally, little or no evidence for variations in the IMF in our galaxy or nearby galaxies.