Supplying angular momentum to the jittering jets explosion mechanism

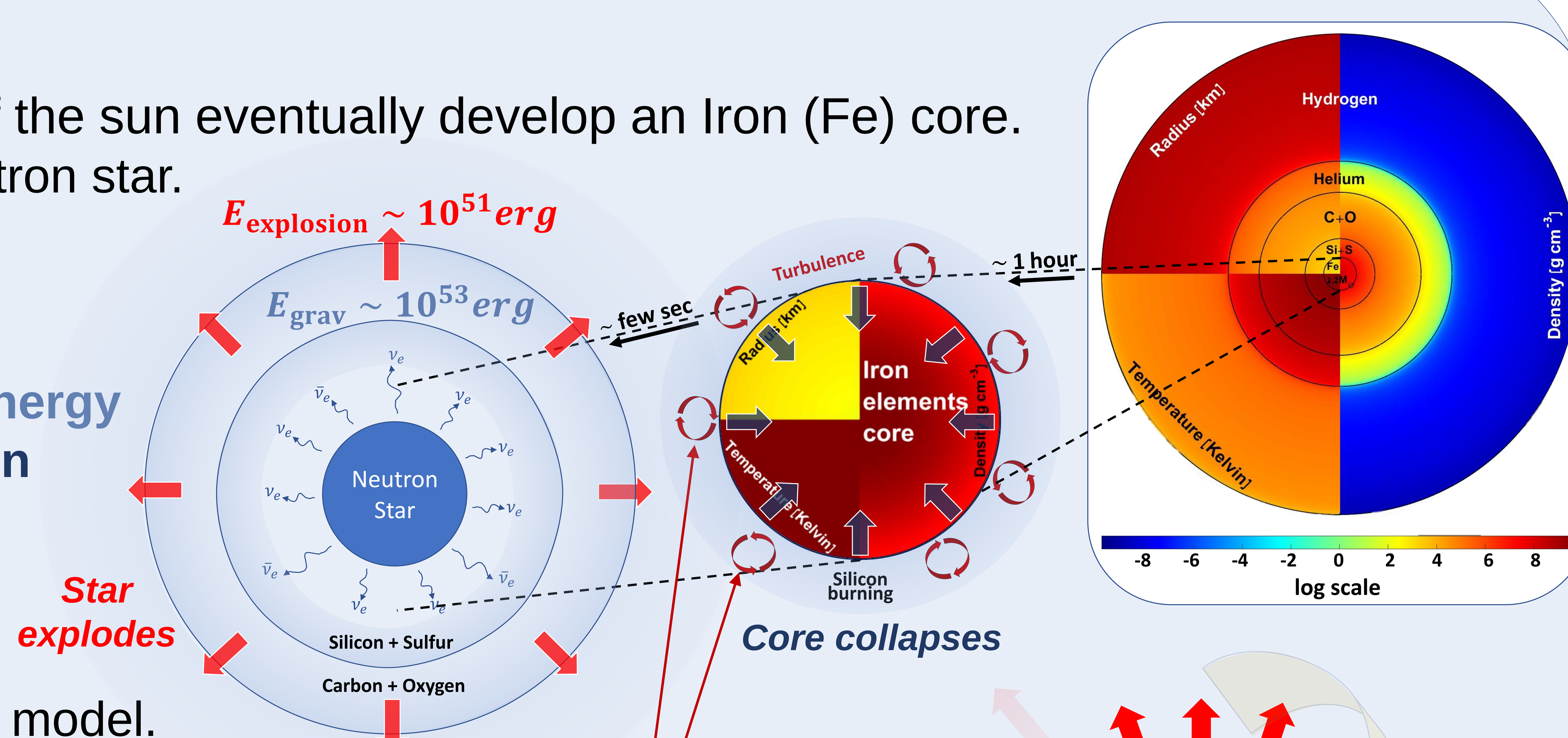
Dmitry Shishkin and Noam Soker

TECHNION Israel Institute of Technology | Department of Physics

Core Collapse Supernova:

Stars more than 10 times the mass of the sun eventually develop an Iron (Fe) core. This Iron core **collapses** to form a neutron star.

$$e + p = n + \nu_e$$



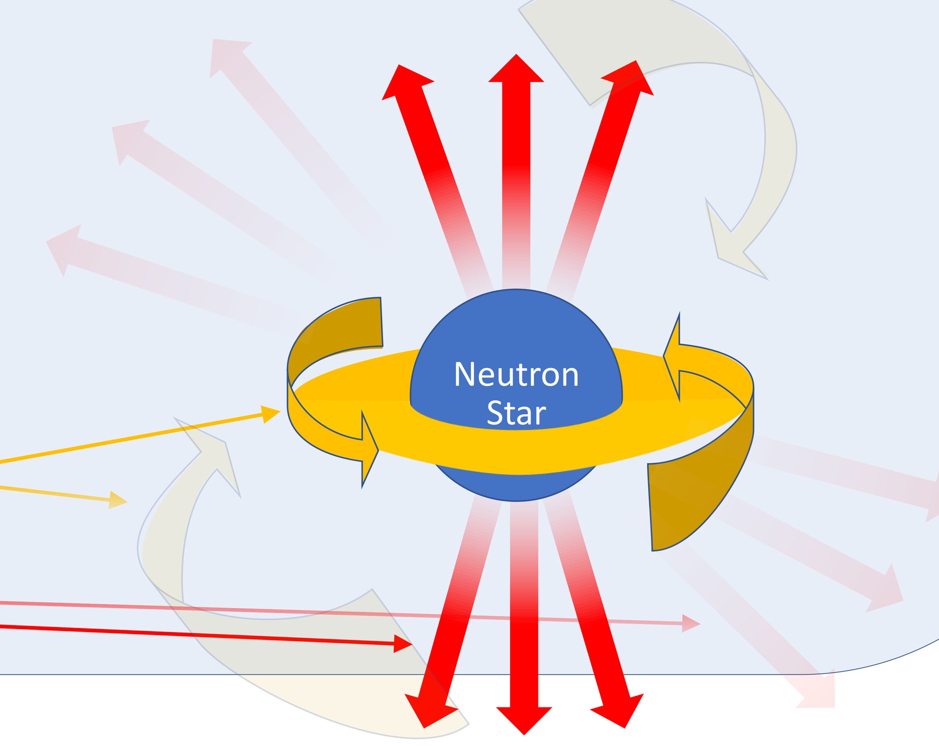
40-year-old question:

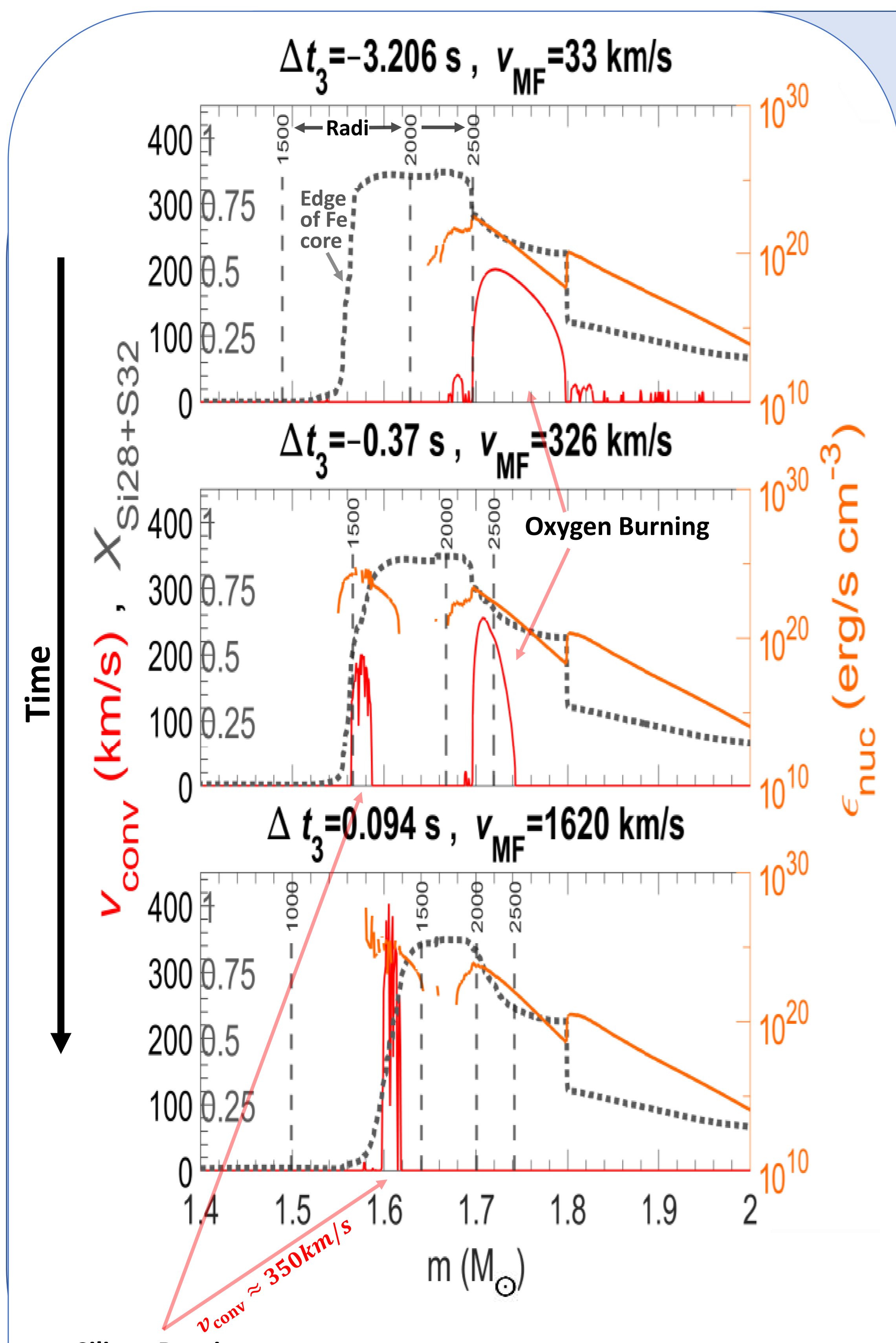
How does ≈ 1% of the **gravitational energy** released during **neutron star formation** **explode** the star?

Solutions:

Neutrino explosion: The conventional model. Neutrinos ($\nu_e, \bar{\nu}_e, \nu_\mu, \bar{\nu}_\mu, \nu_\tau, \bar{\nu}_\tau$) heat the exploding gas. Albeit popular, has fundamental issues.

Jittering jets explosion: We suggest that **stochastic angular momentum fluctuations** in the collapsing core give rise to **stochastic accretion disks** that launch **jittering jets**.



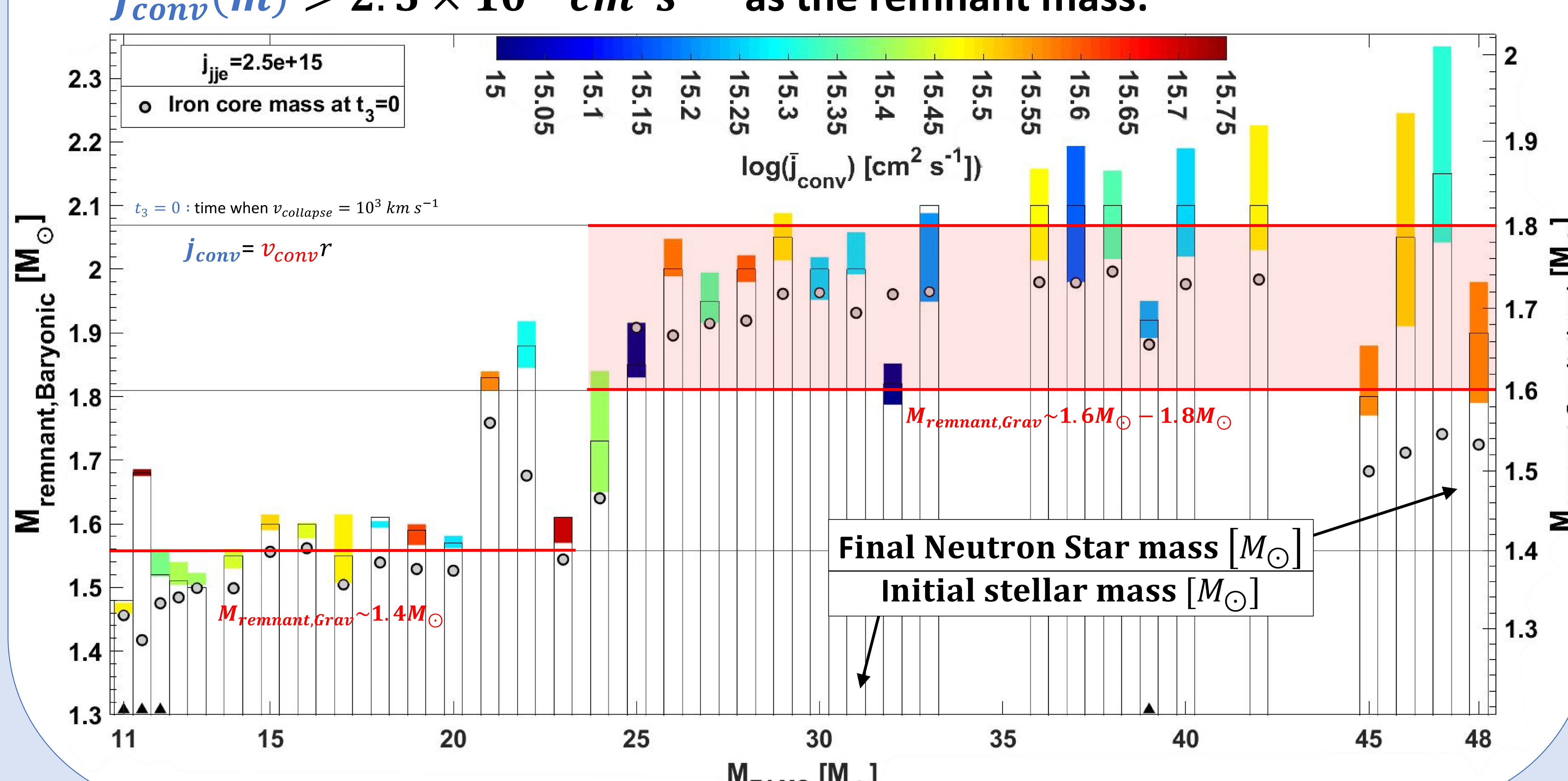


The **convection** becomes stronger during the **collapse** and supplies **perturbation** seeds that form **stochastic accretion disks.**

Results

From 1D stellar evolution simulation models using MESA we get the convective zones.

Taking the inner most convective region mass coordinate that satisfies $\bar{j}_{conv}(m) > 2.5 \times 10^{15} cm^2 s^{-1}$ as the remnant mass:



Shishkin&Soker2021 DOI: 10.1093/mnrasl/slab105 (Figure 1)
Convective velocities , S+Si faction , Nuclear energy production for $M_{ZAMS} = 15 M_\odot$ stellar model

Shishkin&Soker2022 DOI: 10.1093/mnras/stac1075 (Figure 1)
Remnant masses according to the *jittering jets explosion mechanism* for $11 M_\odot < M_{ZAMS} < 48 M_\odot$

Conclusion

- We find vigorous convective regions at core collapse to have sufficient angular momentum fluctuations to explode the star according to the ***jittering jets explosion mechanism***.