

Multimessenger signals from core-collapse supernovae

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February 27, 2020

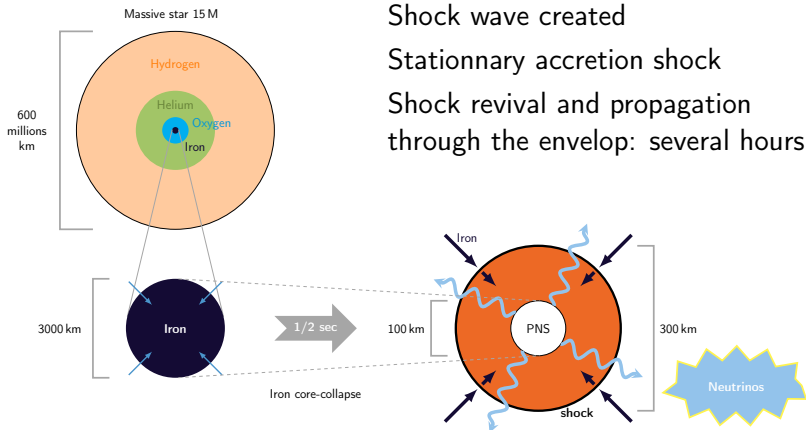


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PARIS-SACLAY

- 1 Core-Collapse Supernova
- 2 Multimessenger signatures of instabilities
- 3 Neutrino-driven convection
- 4 Conclusion

The collapse and the stalled shock

Massive stars end-of-life (8 to 40 M_{\odot}) :



Iron core : 10^3 km / 10^1 km in less than a second

Shock wave created

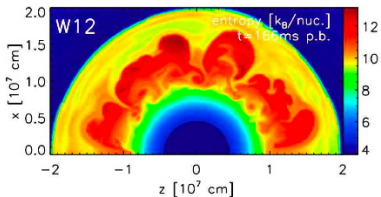
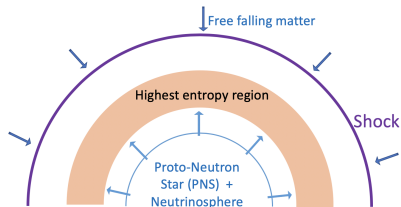
Stationary accretion shock

Shock revival and propagation

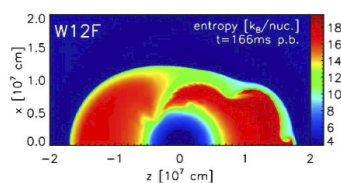
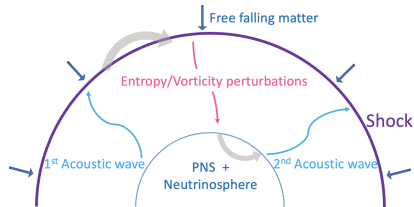
through the envelop: several hours

Neutrino-driven convection and Standing Accretion Shock Instability (SASI)

Neutrino-driven convection



SASI



Foglizzo + 2006

Expected observations of SASI

Neutrinos (27 M)

SASI

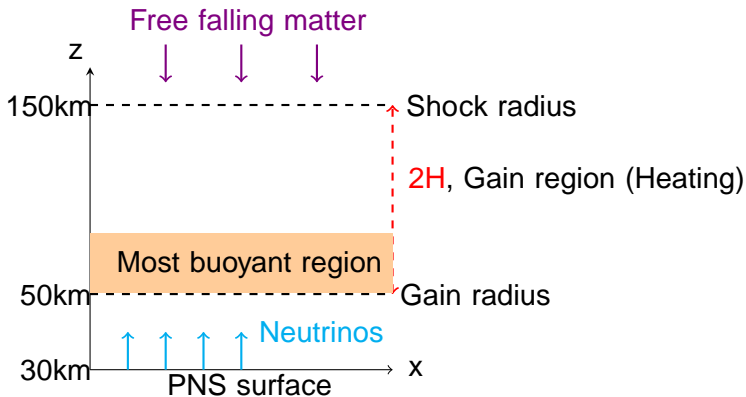
Gravitational waves (15 M,
10kpc)

SASI

Tamborra +2013

Kuroda +2016

An idealised model of the gain region



The stability criterion and length scales

Stability criterion :

$$\frac{\tau_{\text{adv}}}{\tau_{\text{buoy}}}$$

$\tau_{\text{adv}} = \frac{H}{|v|}$, advection
timescale

τ_{buoy} , time required
for the instability to
develop

M , the Mach number

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Toward a new criterion

Several length scales :

H_S , the size of the most buoyant region

$H_\rho = \frac{c_s^2}{g}$, the density scale-height

$$\text{crit} = \left[\frac{\gamma-1}{\gamma} \frac{\Delta S}{\tanh\left(\frac{\gamma-1}{2\gamma} \Delta S\right)} \right]^{1/2} \sqrt{\frac{H_S}{H_\rho}}$$

