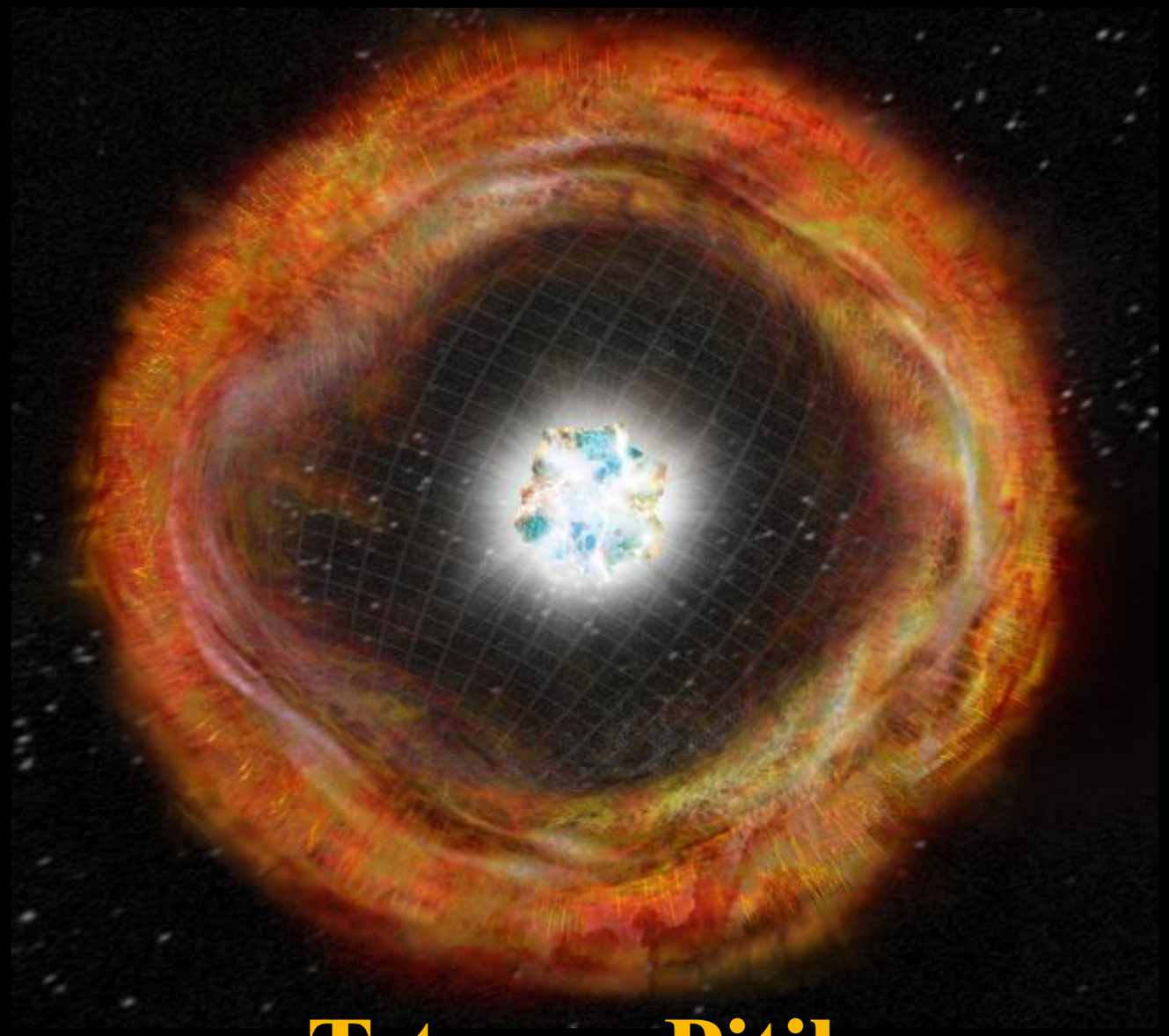
High-energy neutrinos from interacting supernovae



Tetyana Pitik
Niels Bohr Institute

UNIVERSITY OF COPENHAGEN

CARLSBERG FOUNDATION

N3AS Annual meeting

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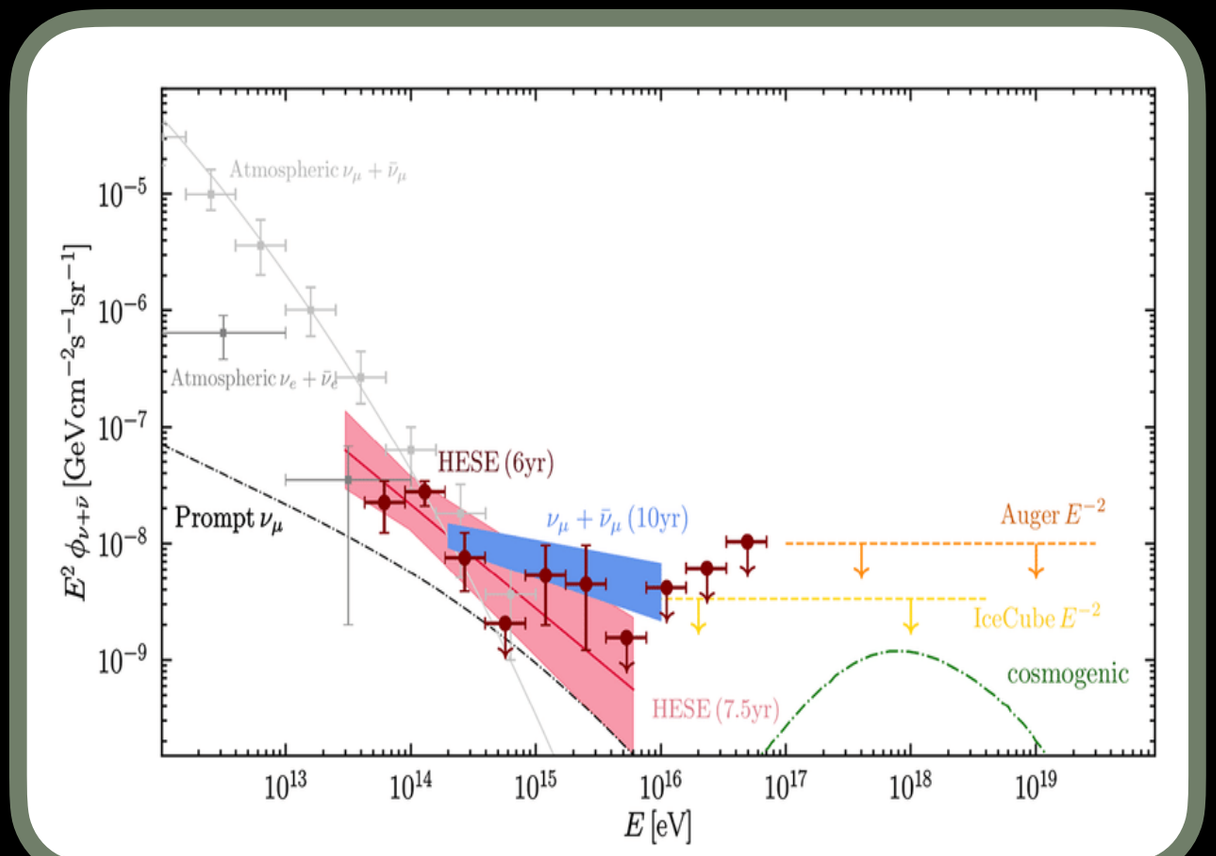
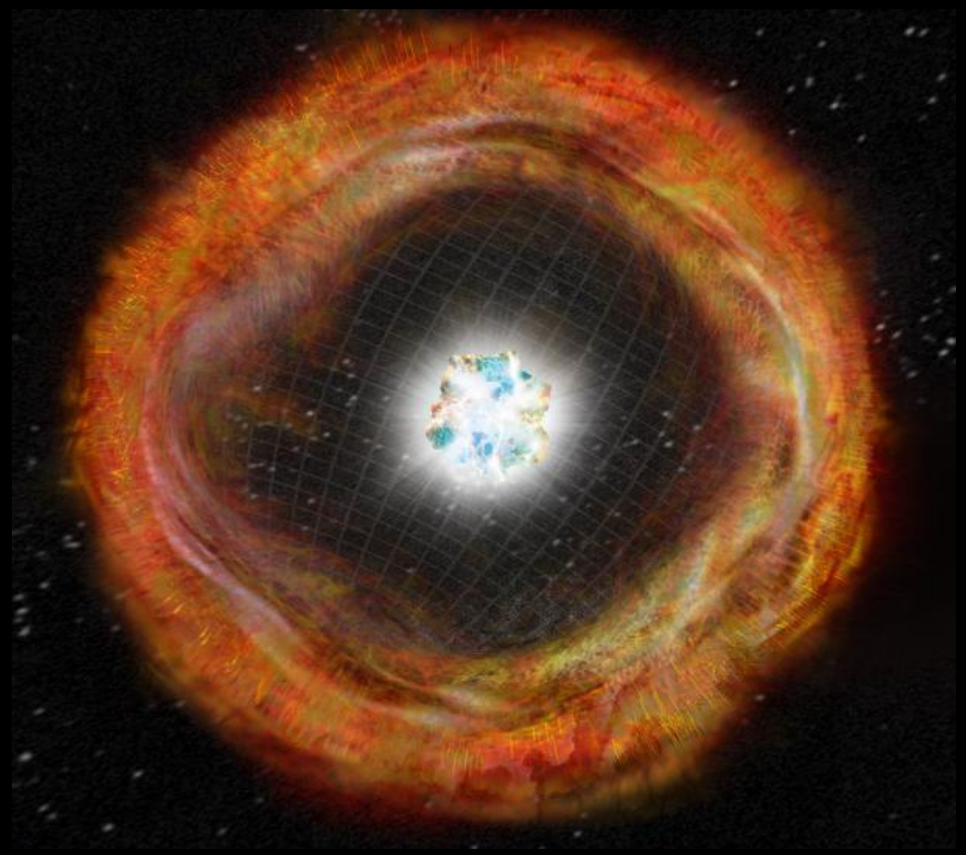
Motivation

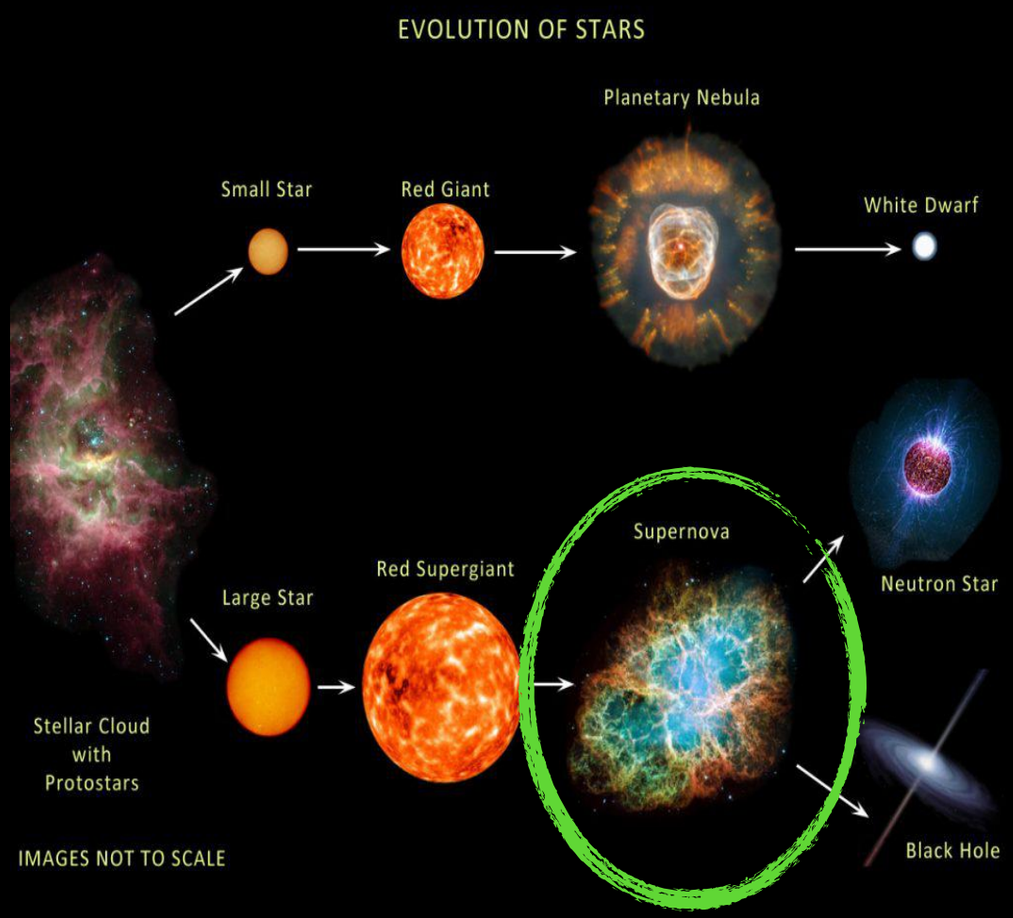
Hunting for the source producing the bulk of Ice Cube neutrinos



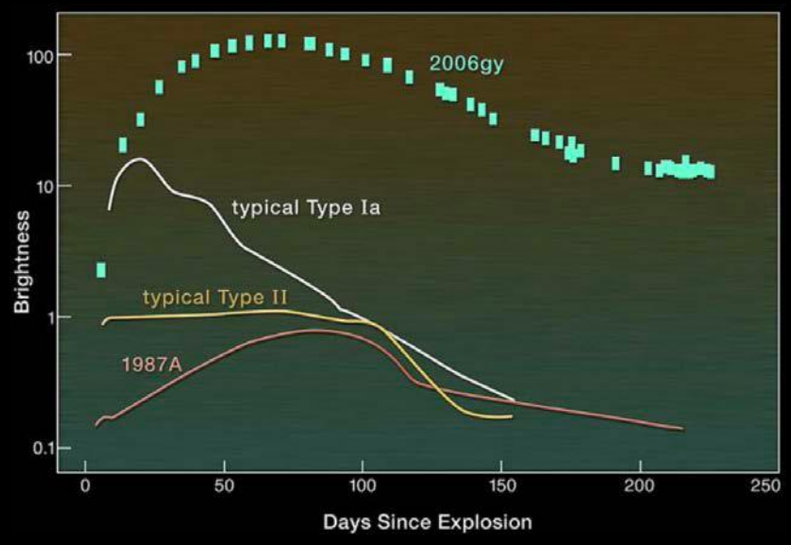
IceCube Collaboration is planning to do a stacked analysis on interacting supernovae. They need an efficient searching strategy

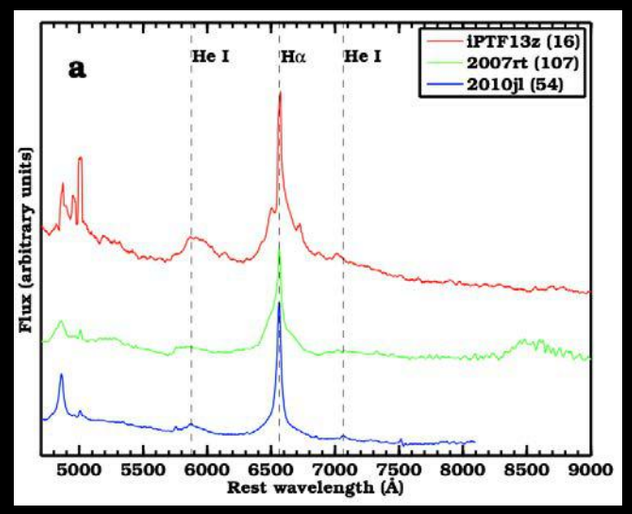


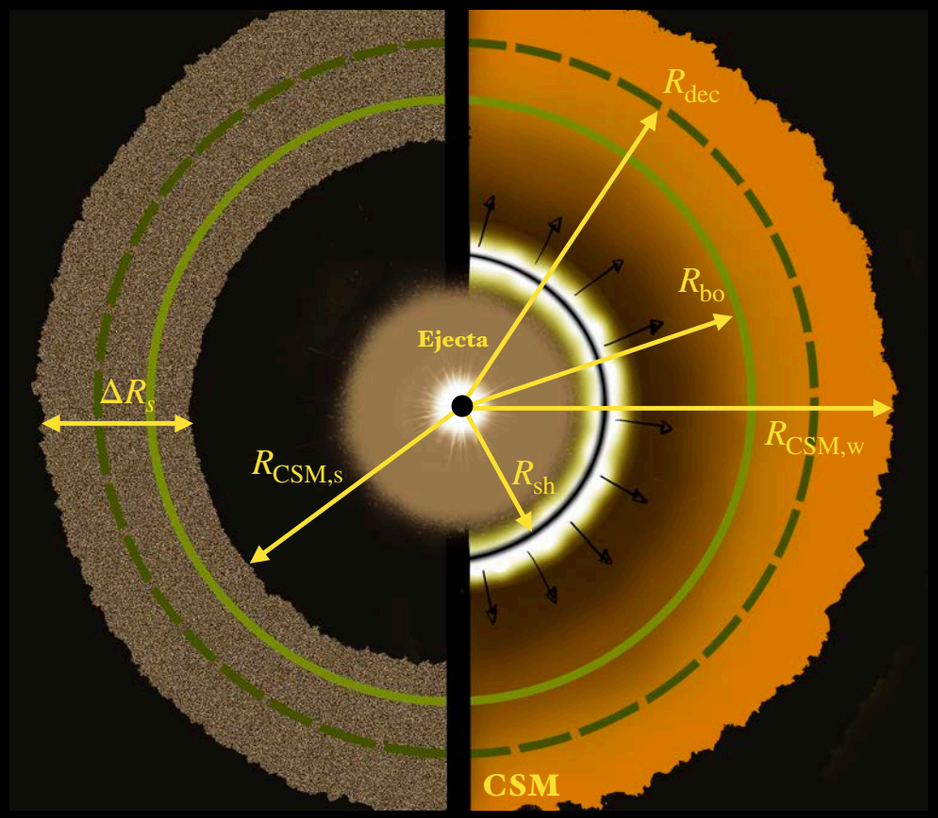
Supernovae and super luminous supernovae Type IIn



~ 10 – 100 times brighter than typical SNe with strong narrow Hα

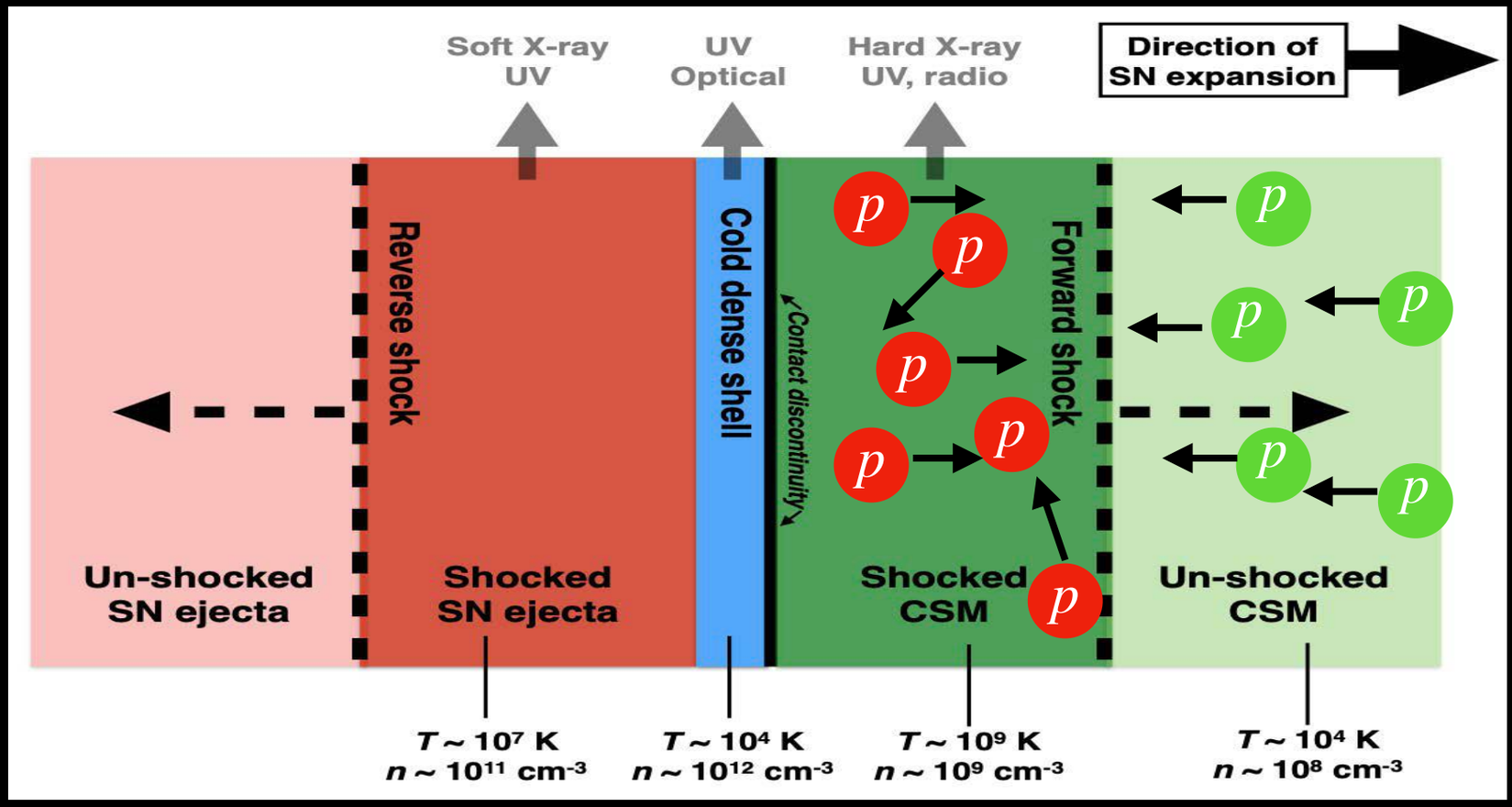






likely energy source: strong interaction with circumstellar material

Neutrino production in interacting supernovae



hadronic interaction

$$\frac{\partial N_{\rm p}(\gamma,R)}{\partial R} = \frac{\partial}{\partial \gamma}\left[\frac{\gamma}{R} N_{\rm p}(\gamma,R)\right] - \frac{N_{\rm p}(\gamma,R)}{v_{\rm sh} t_{pp}(R)} + Q_{\rm p}(\gamma,R)$$

$$p + p \longrightarrow X + \text{many}(\pi^0 + \pi^+ + \pi^-)$$

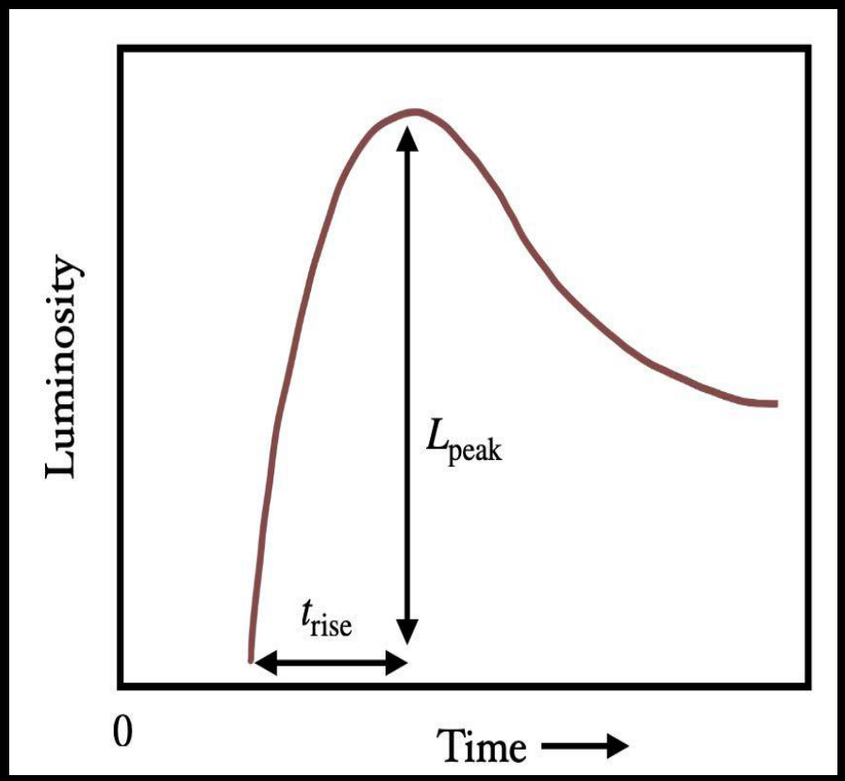
$$\pi^+ \longrightarrow \mu^+ + \nu_\mu \longrightarrow e^+ + \nu_e + \bar{\nu}_\mu + \nu_\mu$$

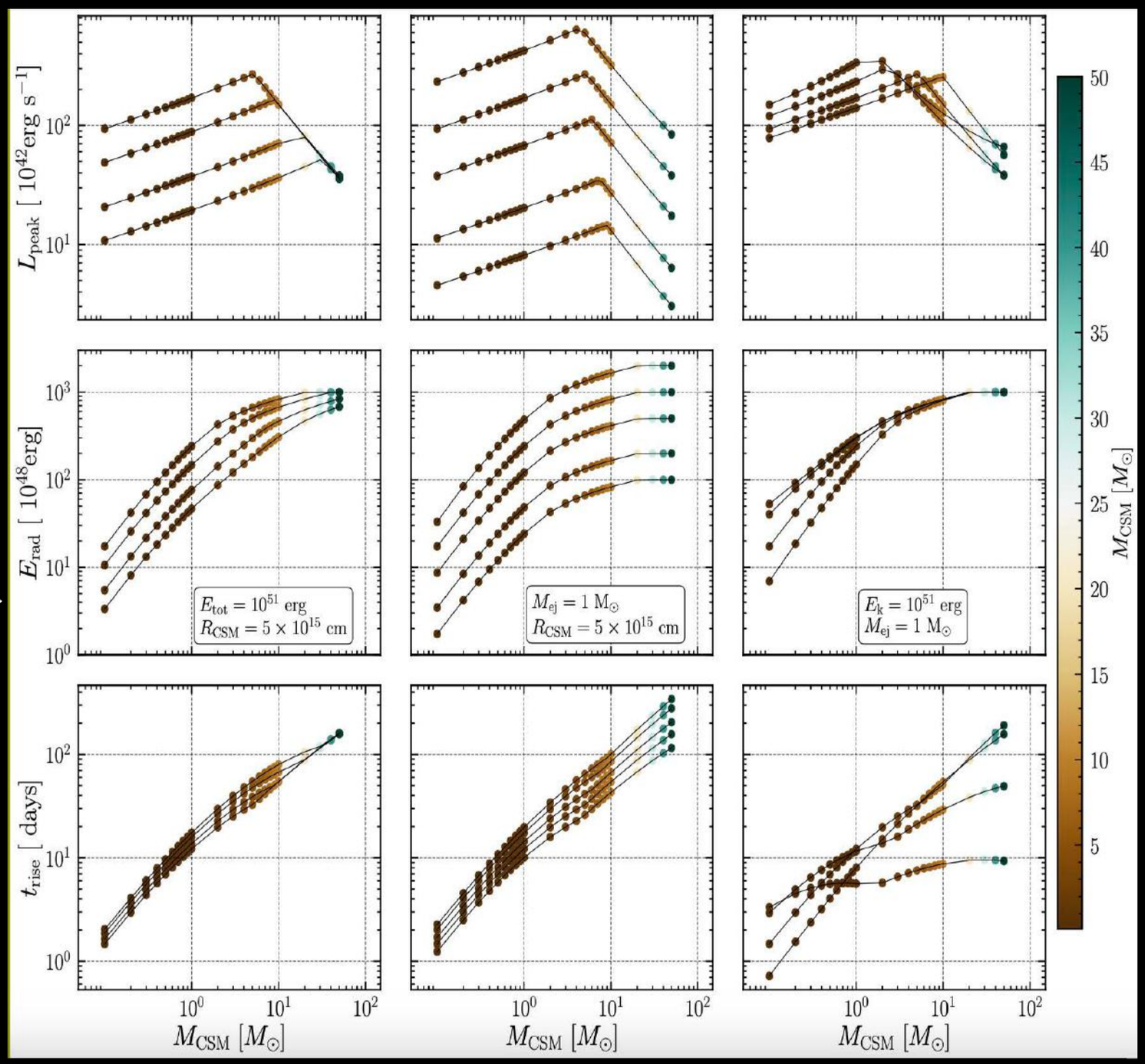
$$\pi^- \longrightarrow \mu^- + \bar{\nu}_\mu \longrightarrow e^- + \bar{\nu}_e + \nu_\mu + \bar{\nu}_\mu$$

Connection between light curve properties and SNe parameters

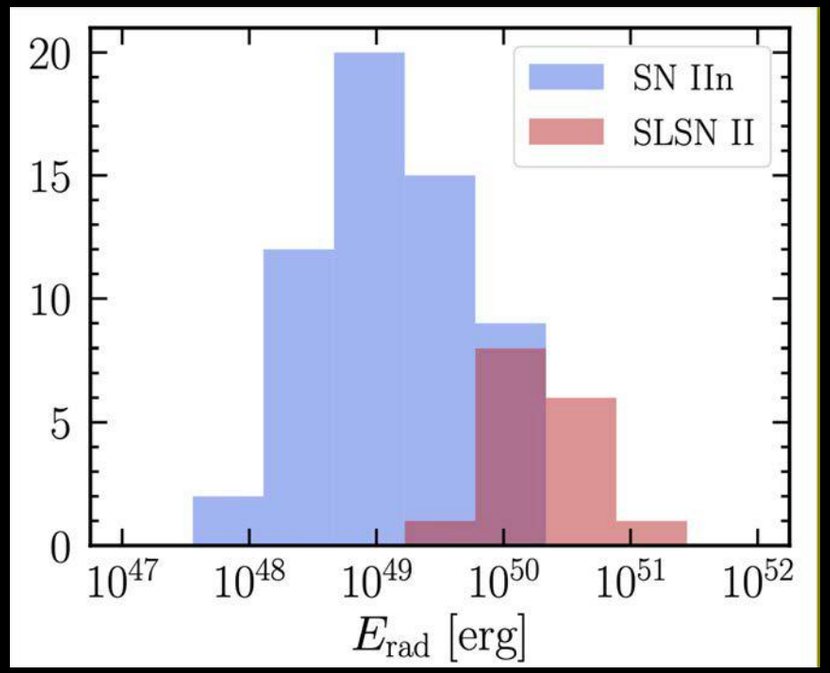
"First-order" properties of the SN lightcurves:

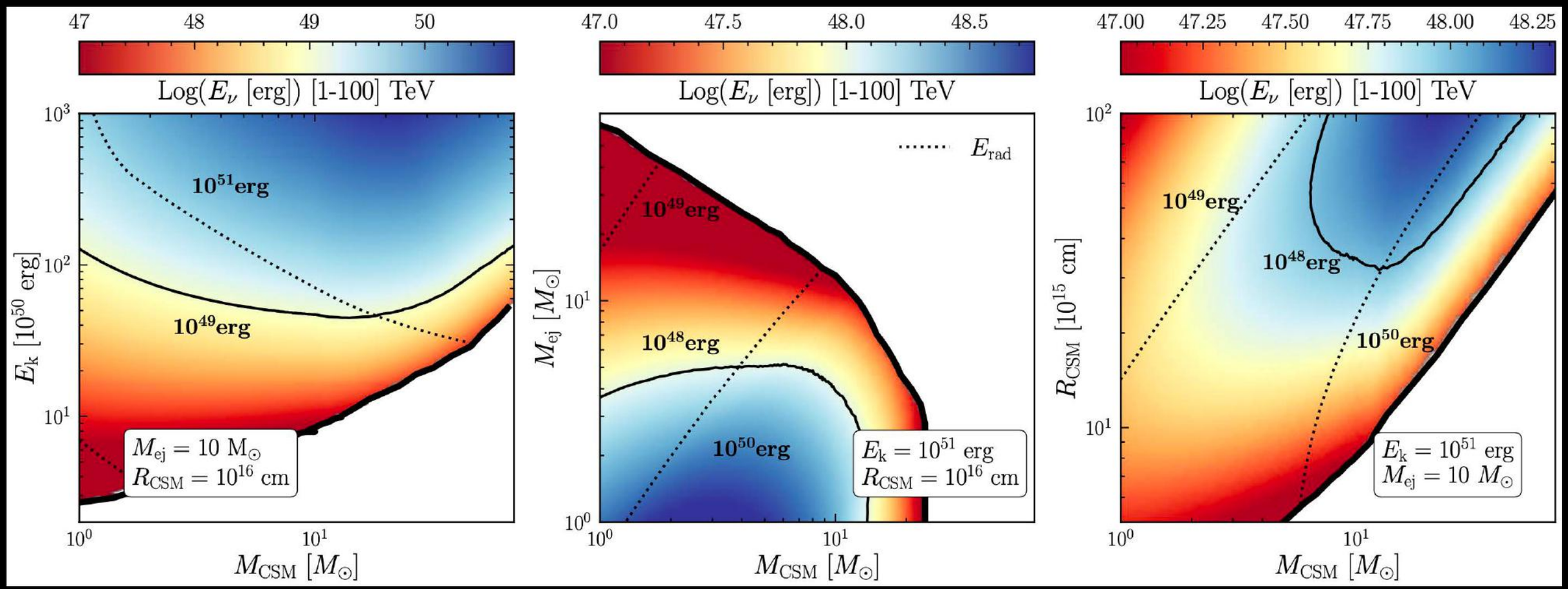
- peak luminosity
- rise time
- radiated energy



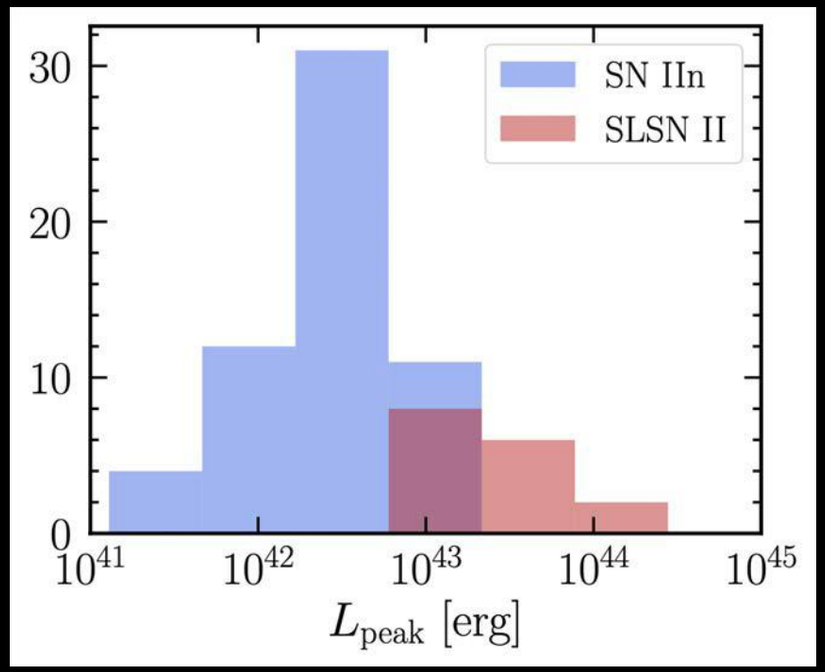


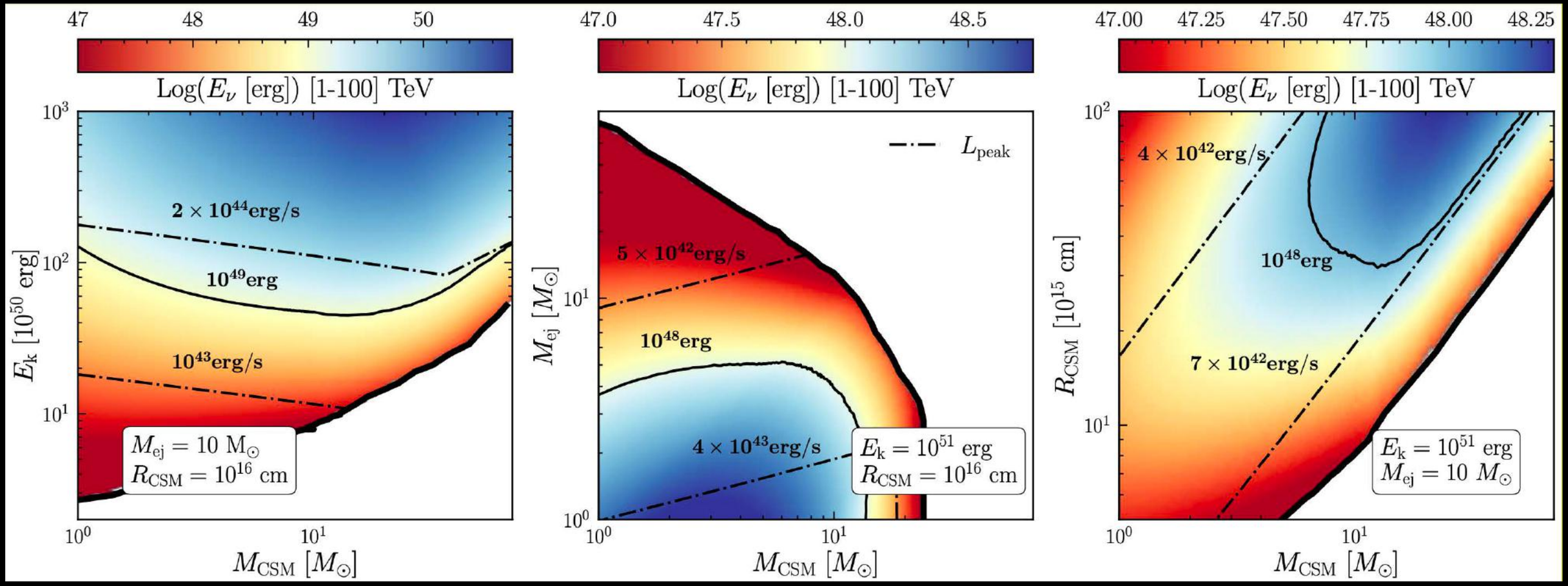
Connection between light curve properties and neutrinos





Connection between light curve properties and neutrinos





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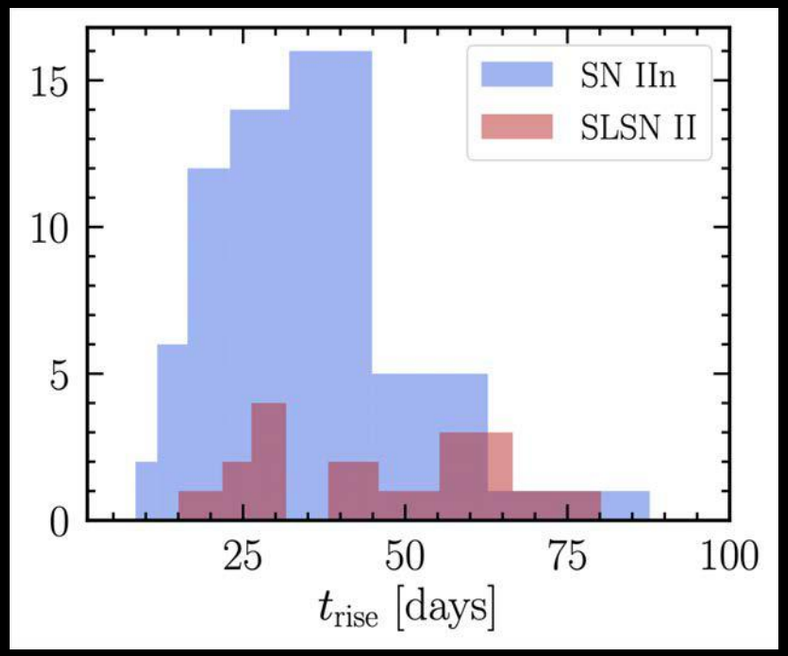

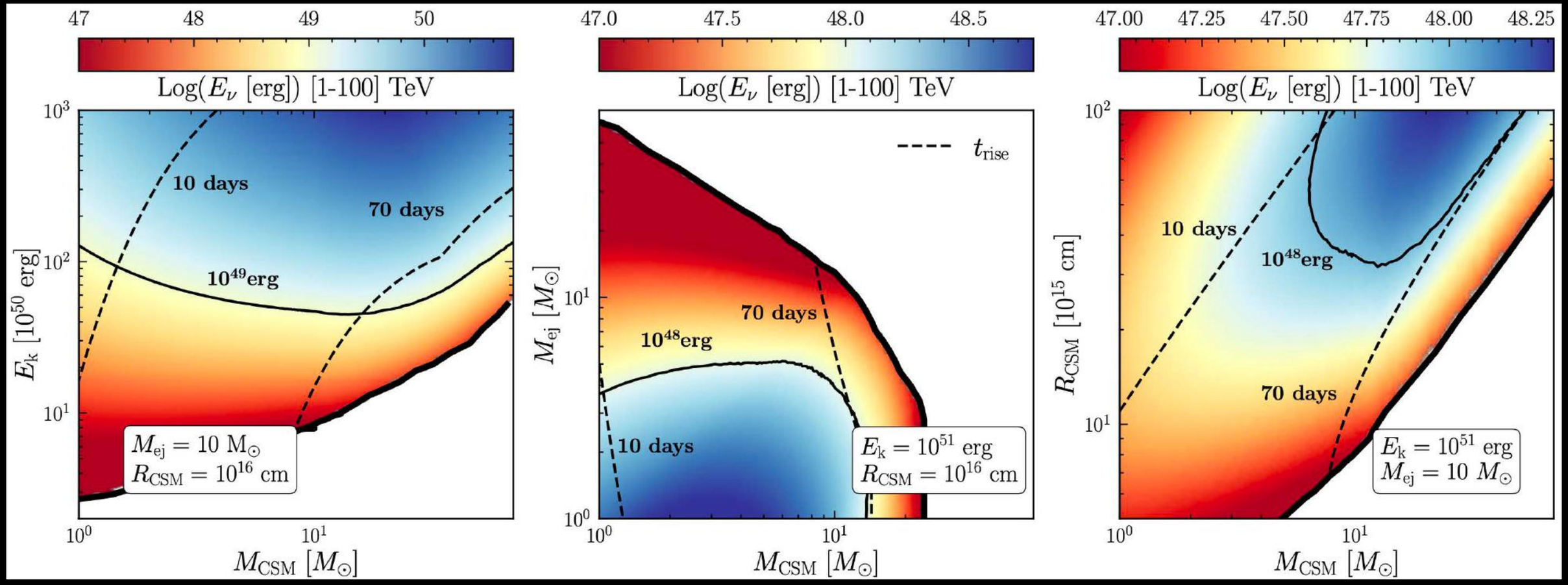

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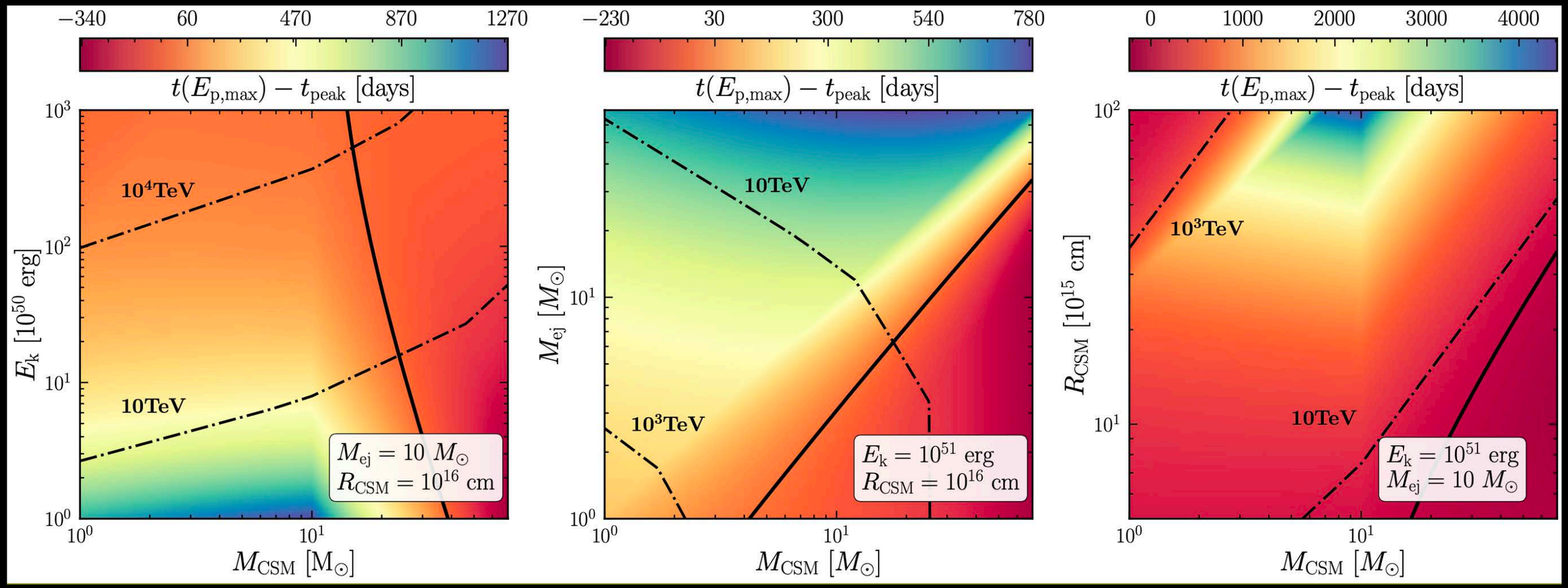

Conclusion

We obtain considerable production of $1-100\,\mathrm{TeV}$ neutrinos for:

$$M_{\rm ej} \lesssim 8\,M_\odot,\ M_{\rm CSM} \lesssim 13\,M_\odot,\ R_{\rm CSM} \gtrsim 10^{16}\,\mathrm{cm}$$

$$L_{\rm peak} \gtrsim 10^{43}\mathrm{erg\,s^{-1}},$$

$$10\,\mathrm{days} \lesssim t_{\rm rise} \lesssim 60\,\mathrm{days}$$

$$10^{50}\,\mathrm{erg} \lesssim E_{\rm rad} \lesssim 10^{51}\mathrm{erg}$$

$$t \gtrsim 200-300\,\mathrm{days}\ \textbf{after peak}$$