

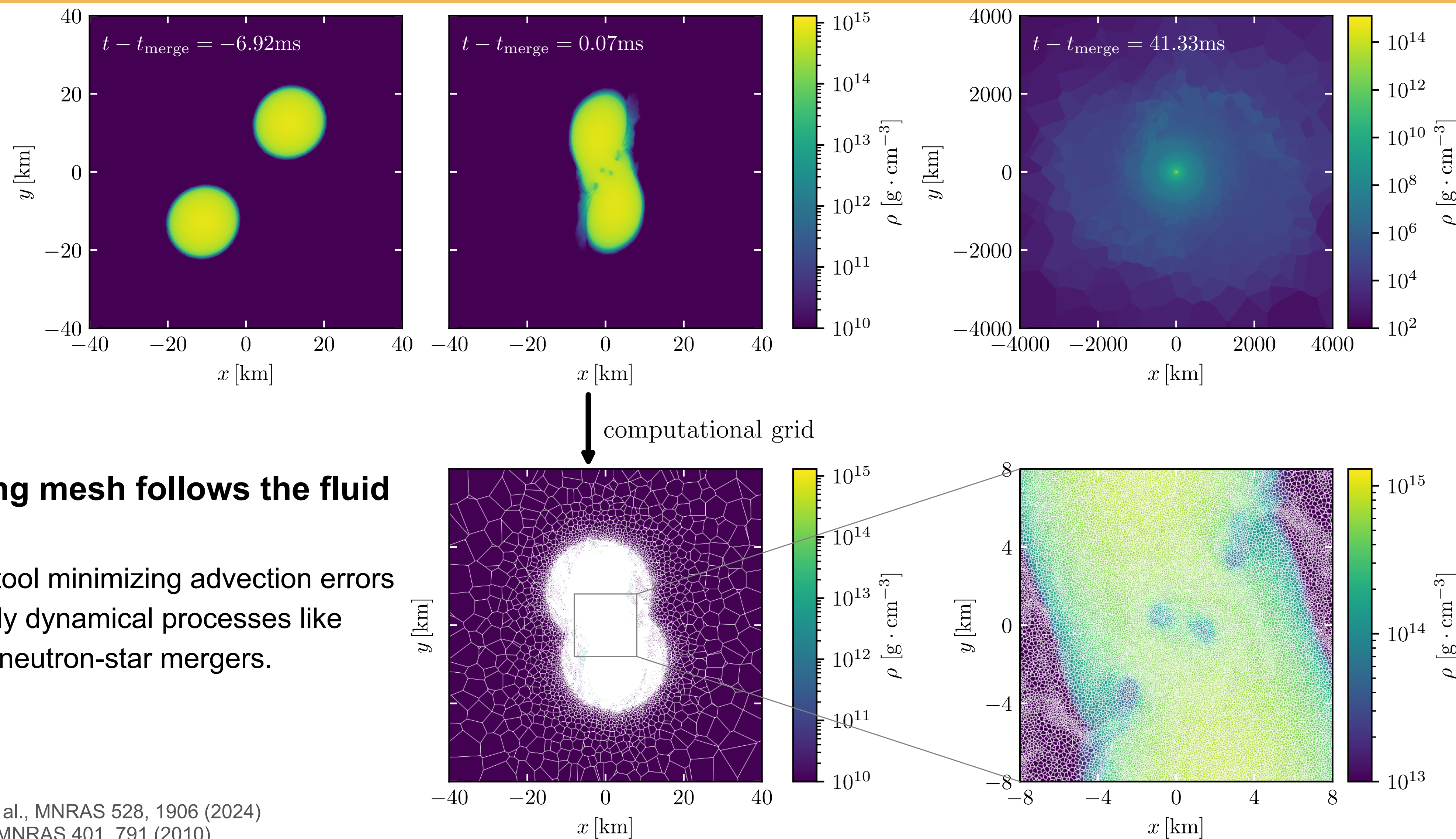
Binary neutron-star merger simulations on a moving mesh

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Relativistic hydrodynamic simulations with *AREPO*



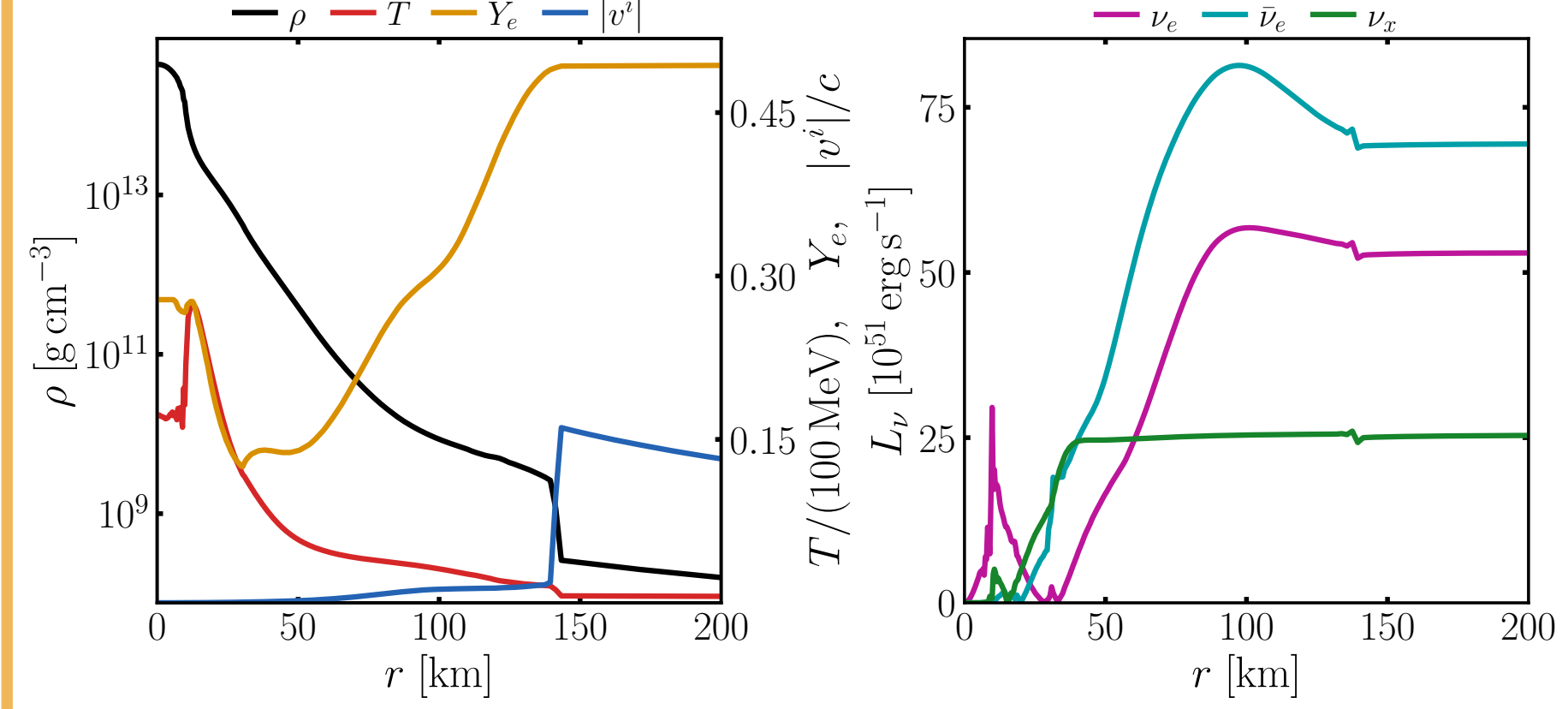
Moving mesh follows the fluid

Novel tool minimizing advection errors in highly dynamical processes like binary neutron-star mergers.

Lioutas et al., MNRAS 528, 1906 (2024)
Springel, MNRAS 401, 791 (2010)

Neutrino transport

• Neutrino transport is **essential** for predicting the **composition** of **outflows** and conditions for nucleosynthesis of **heavy elements**.

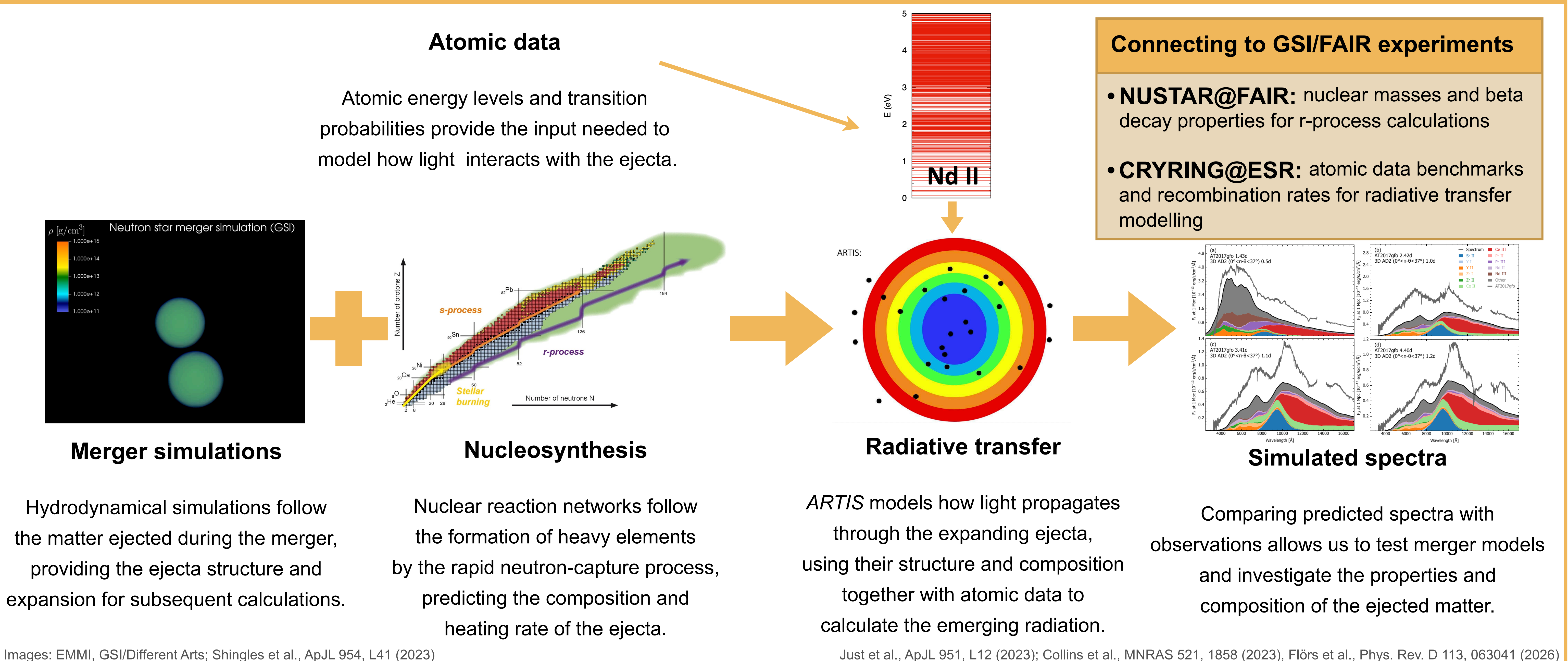


• We are implementing **gray M1 transport** in *AREPO*, evolving the neutrino energy density and flux integrated over neutrino energy.

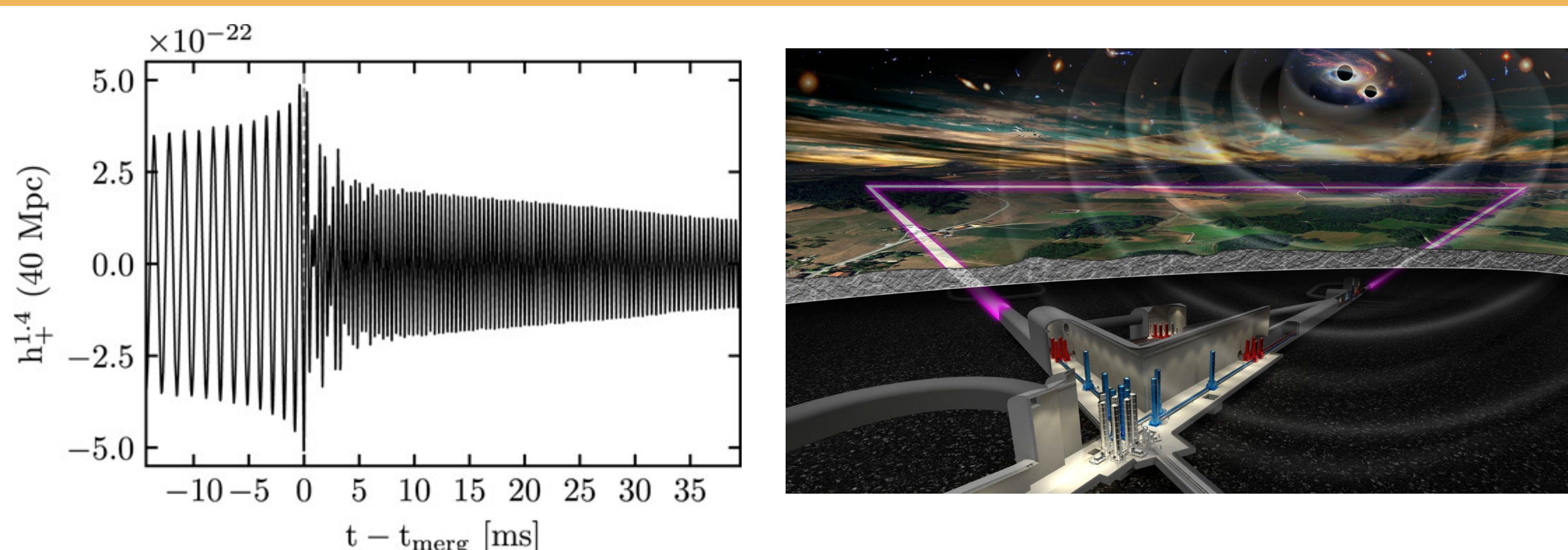
• **Hot proto-neutron-star test:** radial profiles of matter properties (left) and neutrino luminosities (right) for a core-collapse supernova before the onset of explosion.

Nikolaidis et al., PoS FAIRness2024 (2026) 023
Just et al., MNRAS 453, 3386 (2015)

Kilonova pipeline



Gravitational waves and dense matter

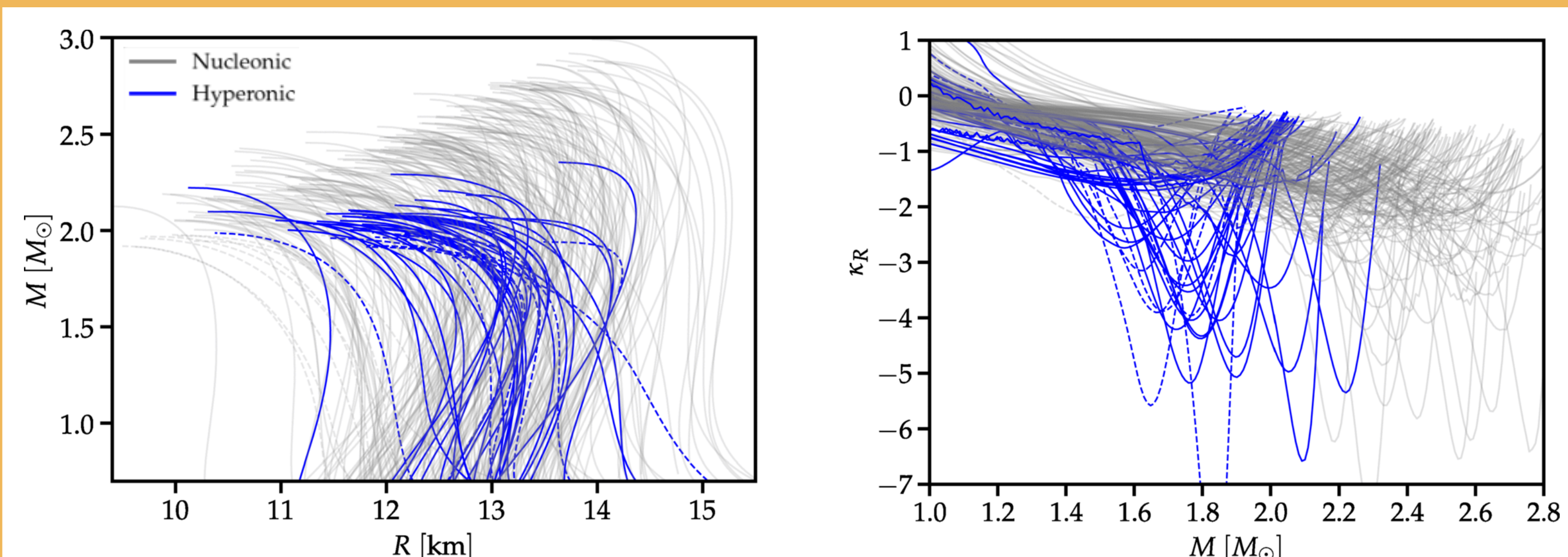


What can the post-merger signal reveal about dense matter?

- Our simulations predict how the neutron-star **equation of state** shapes the remnant's oscillations and **gravitational-wave signal**.
- Today's detectors observe the inspiral. **Einstein Telescope** could also detect the high-frequency **post-merger signal**, probing matter under extreme conditions.
- These observations would complement constraints on dense matter from **CBM@FAIR** experiments.

Image: Einstein Telescope
Blacker et al., Phys. Rev. D 109, 043015 (2024); Abac et al., JCAP 03 (2026) 081

Stellar parameters of neutron stars



Can stellar properties reveal hyperons?

- Hyperons can produce a pronounced bending of the mass–radius relation towards smaller radii. Its **strongly negative curvature** provides a potential **signature** for **hyperonic degrees of freedom** in the cores of neutron stars.
- Other non-nucleonic degrees of freedom, such as quarks, may yield similar signatures. Studies of dense matter with **CBM@FAIR** can help constrain the underlying physics.

Bauswein, Nikolaidis et al., Phys. Rev. Research 8, 013253 (2026)

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