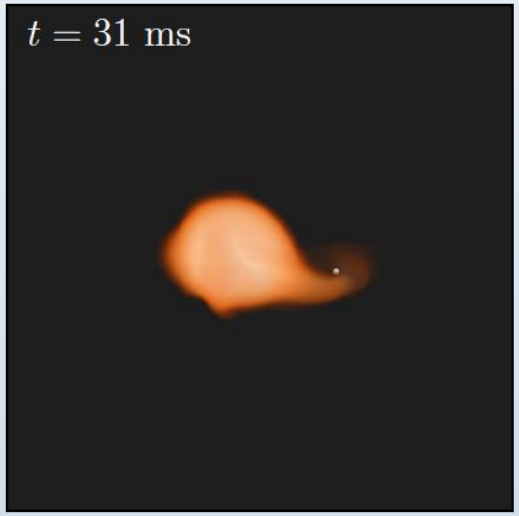
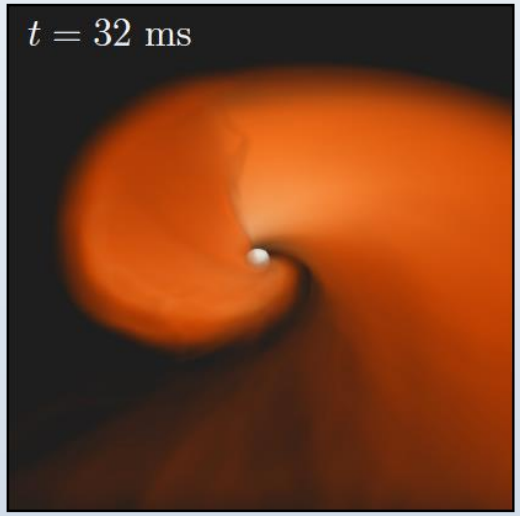
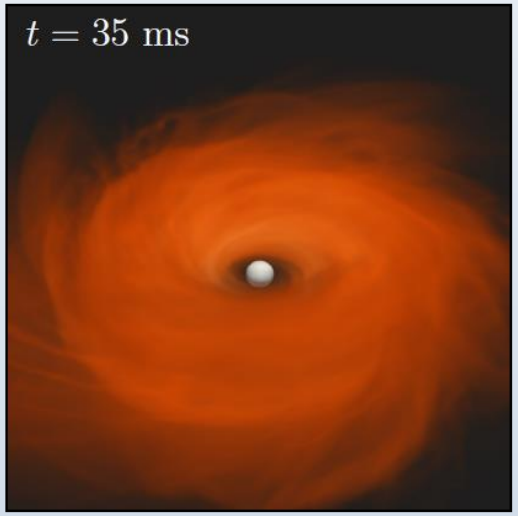
Kilonova from different points of view: Combining 3D radiative transfer and numerical-relativity simulations



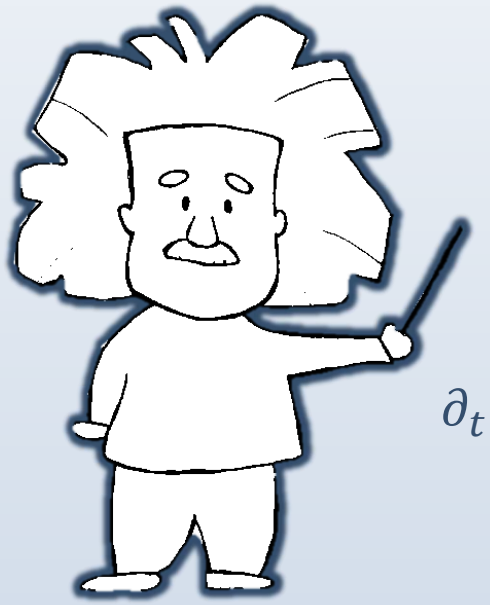




MICRA2023:
Microphysics in Computational Relativistic Astrophysics

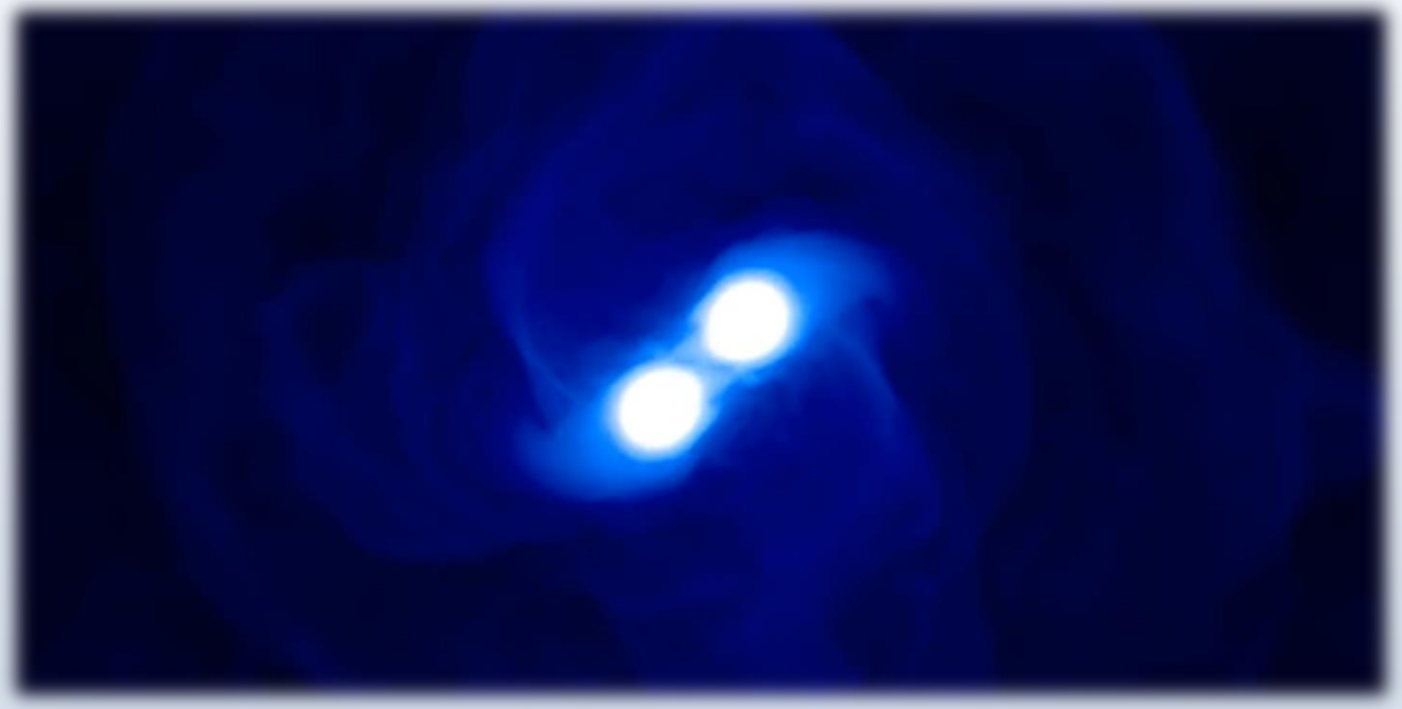
Numerical Relativity Code – BAM [Brügmann et al. 2008]

$$G_{\mu\nu} = 8\pi\, T_{\mu\nu}$$



$$\nabla_\mu T^{\mu\nu} = 0$$
$$\nabla_\mu (\rho_0 u^\mu) = 0$$

$$\partial_t \boldsymbol{q} + \partial_k\, f^k(\boldsymbol{q}) = s(\boldsymbol{q})$$



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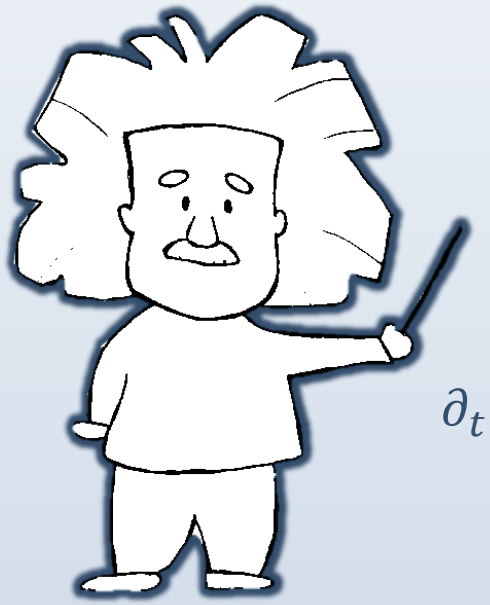

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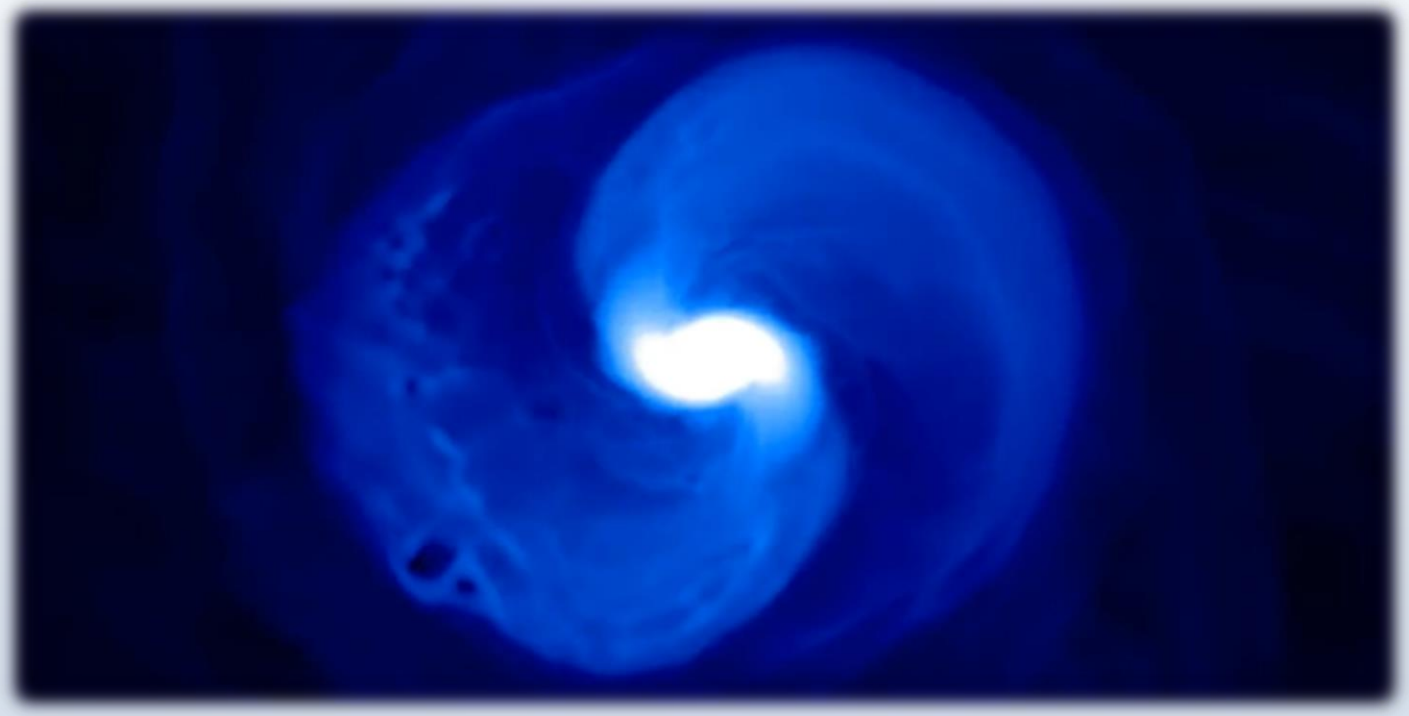

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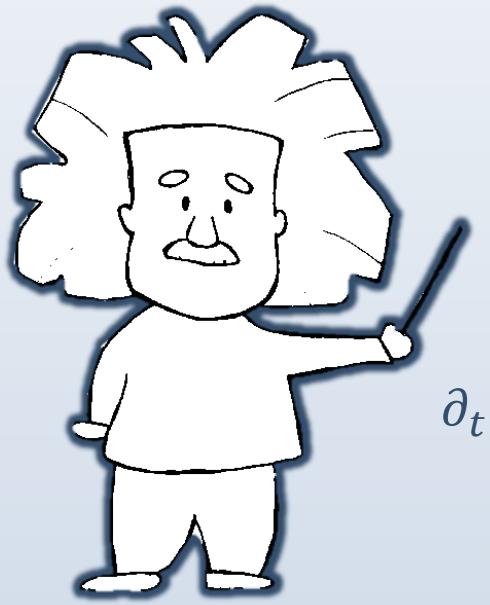

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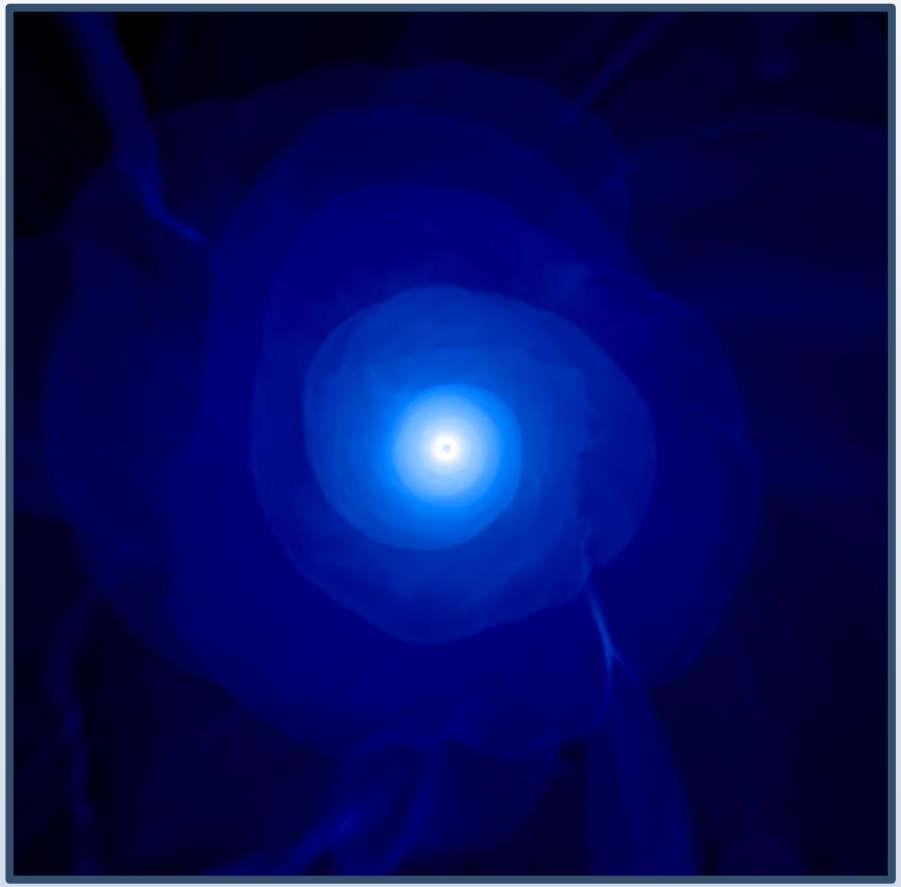
Radiative Transfer Code – POSSIS [Bulla 2019]

- 3D Monte-Carlo simulations
- main steps:
  - setting up model
  - creating photons
  - propagating photons
  - collecting photons



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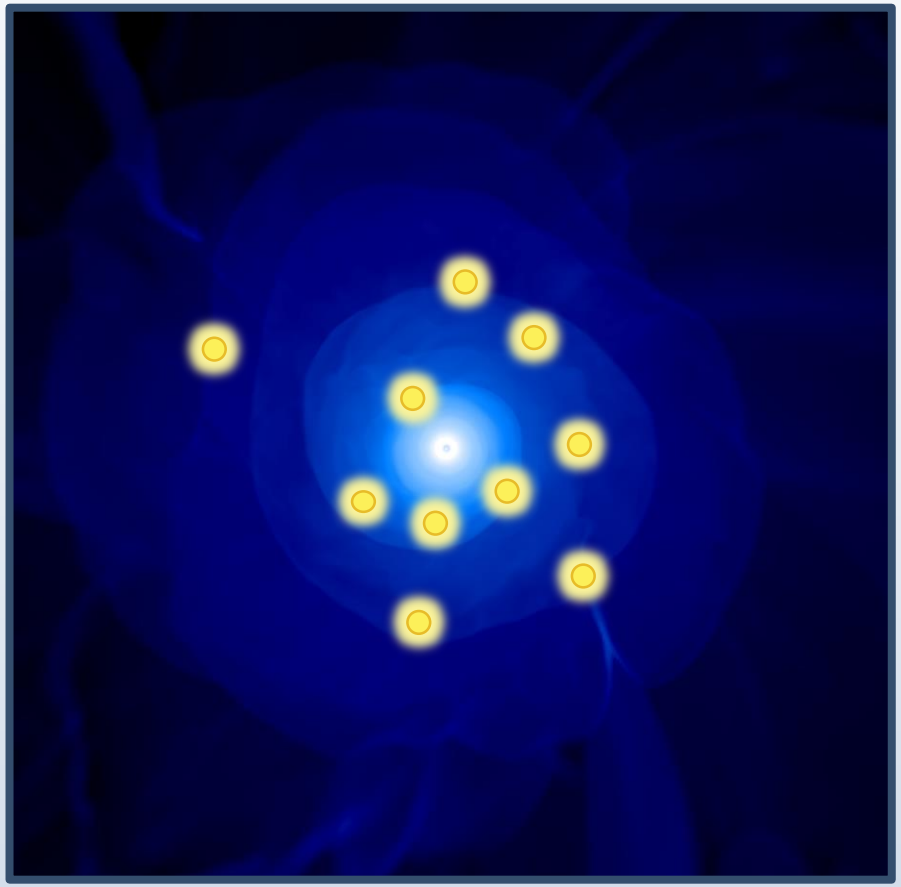

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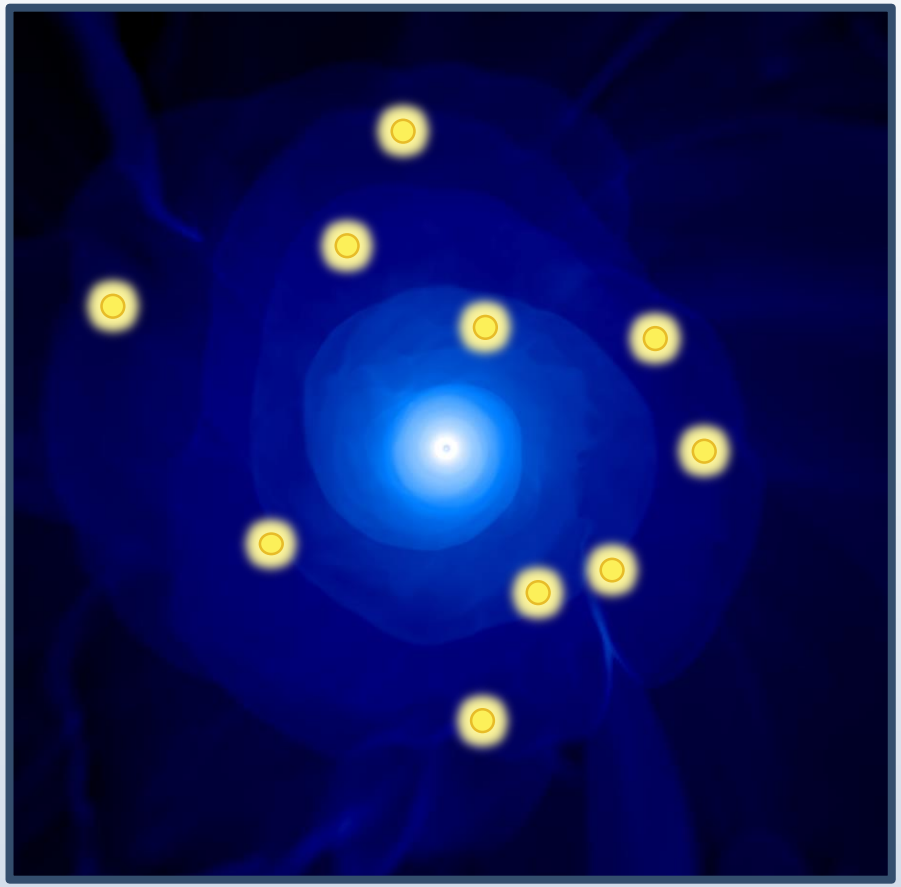

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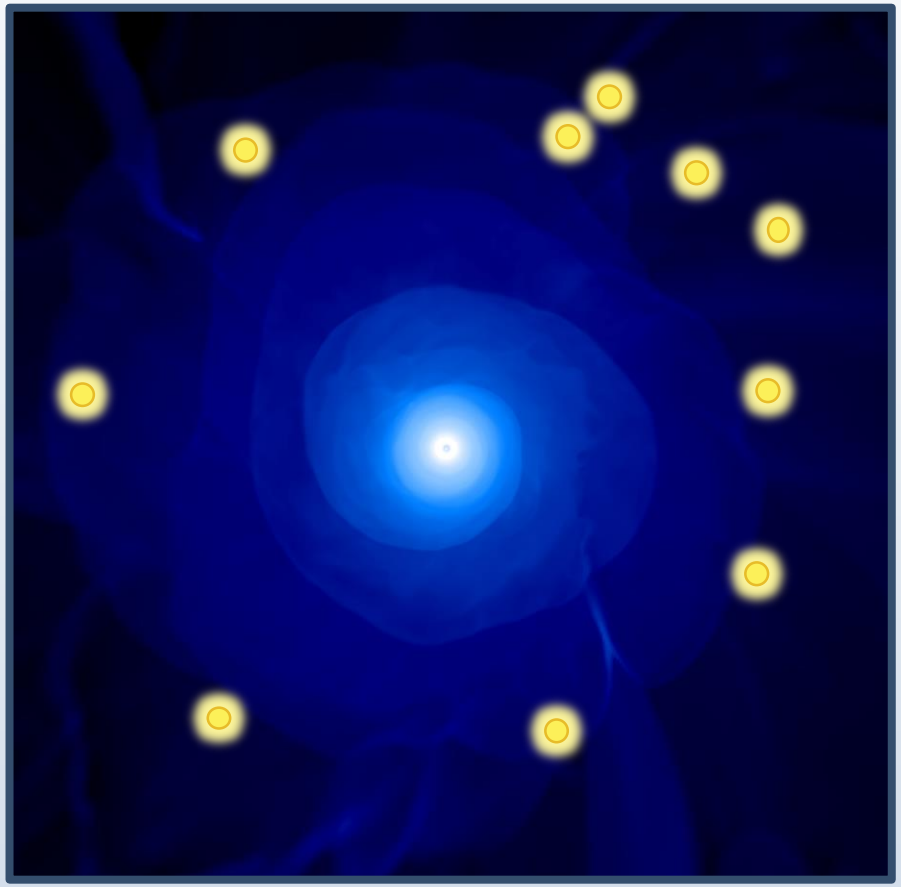
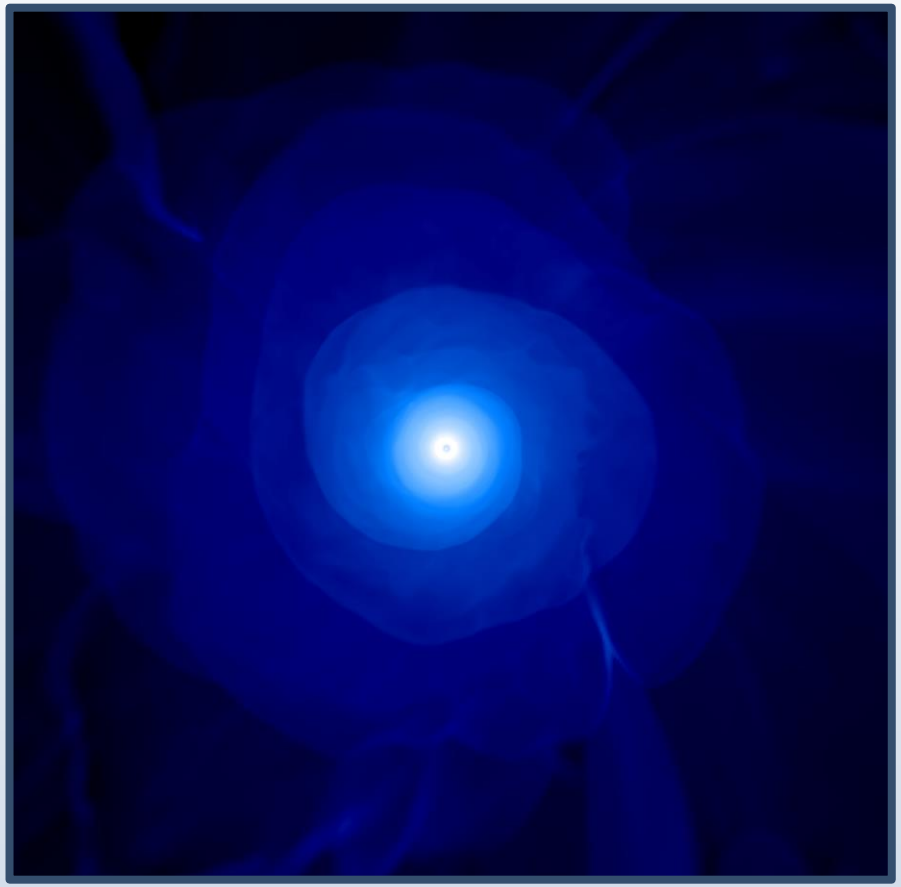
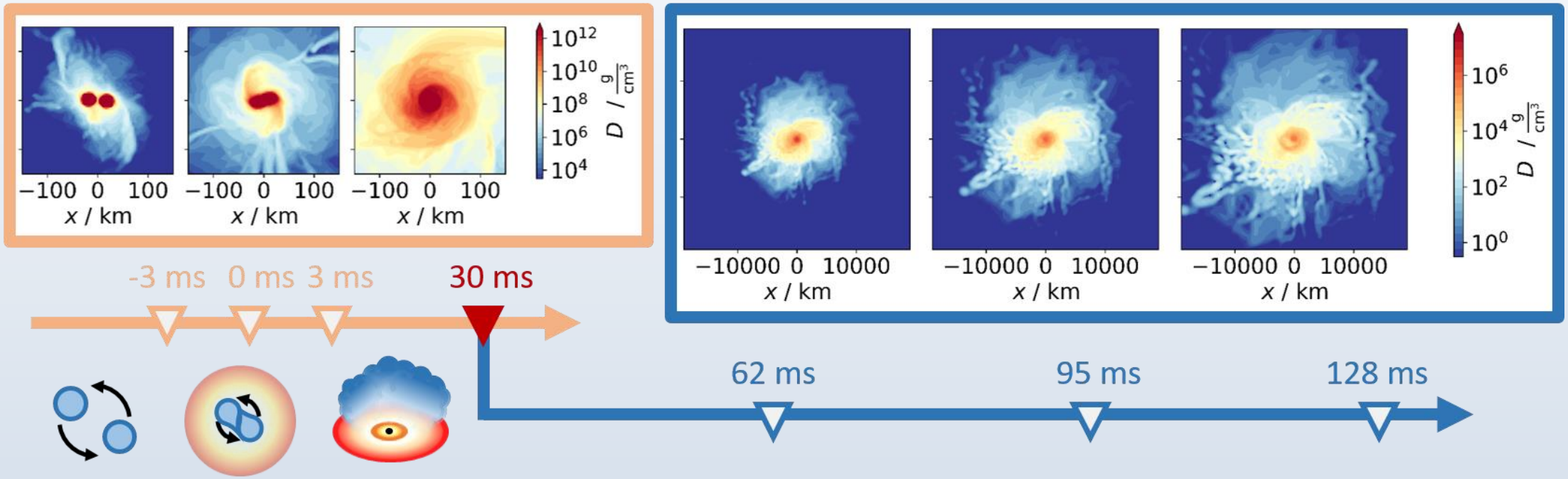


Radiative Transfer Code – POSSIS [Bulla 2019]

- 3D Monte-Carlo simulations
- main steps:
  - setting up model
  - creating photons
  - propagating photons
  - collecting photons
- requires at reference time t_0:
  $(\rho_0, v_x, v_y, v_z, Y_e)$
- assumes homologous expansion with:
  $r_i = v_i(t - t_{\mathrm{merger}})$



Homologous Expansion



Neuweiler et al. 2023
(*Phys. Rev. D* **107**, 023016)

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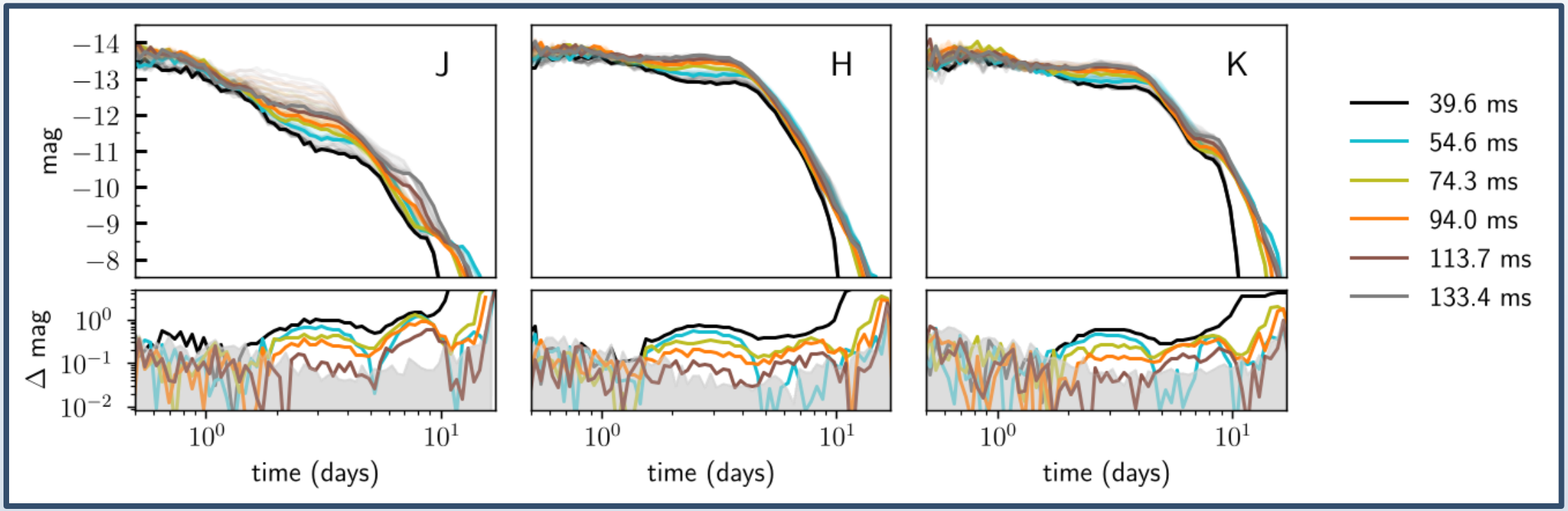

Neuweiler et al. 2023
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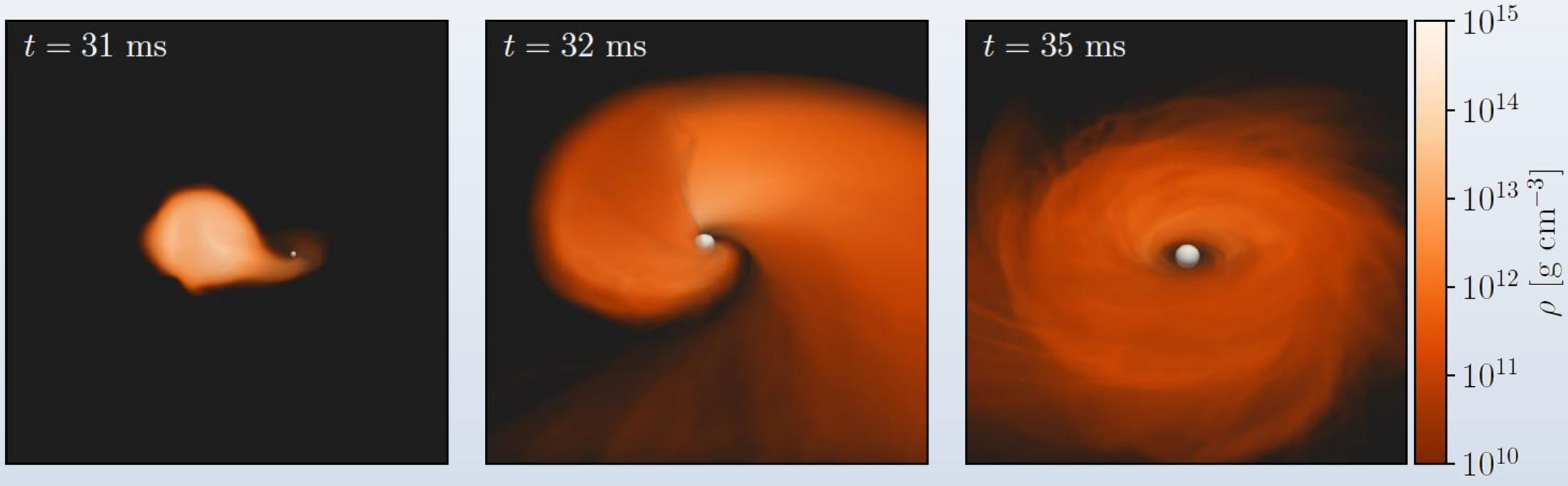
NSbh – Simulation

$M^{\mathrm{BH}} = 0.5\ M_\odot$
$M_g^{\mathrm{NS}} = 1.4\ M_\odot$



Markin et al. 2023
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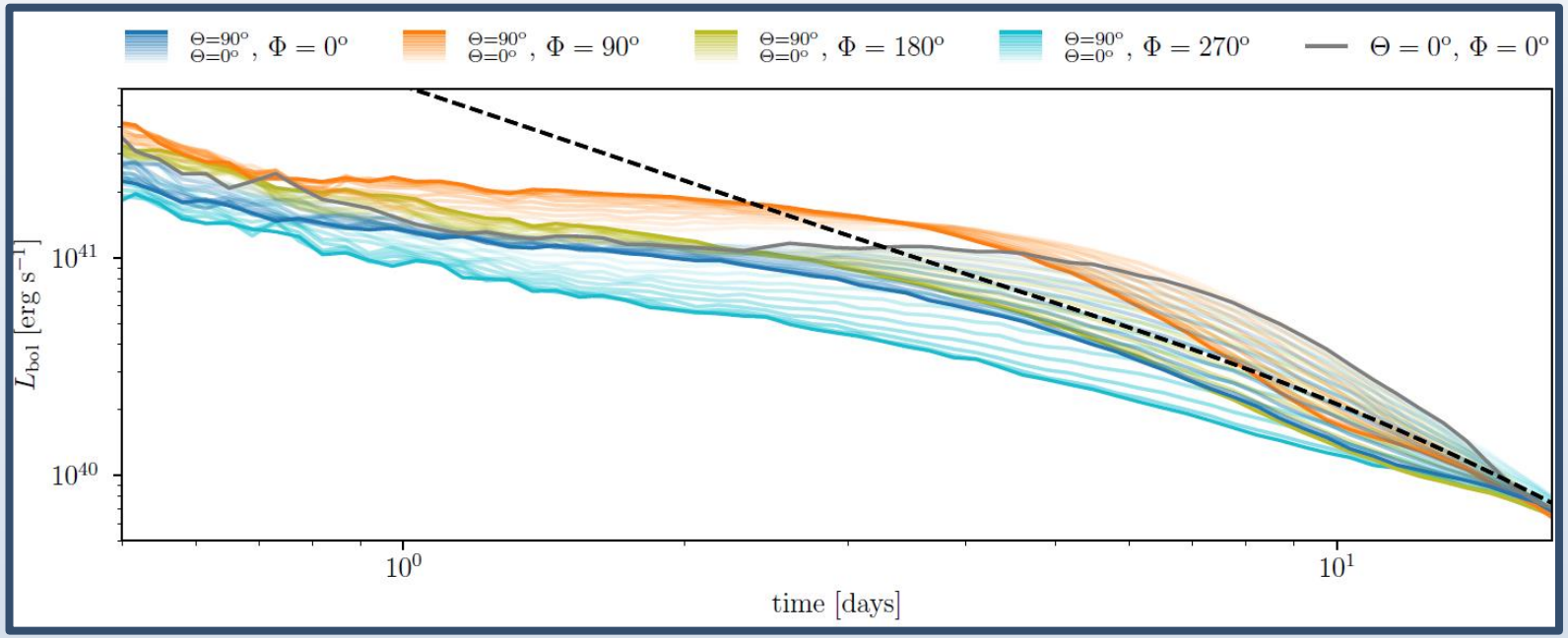
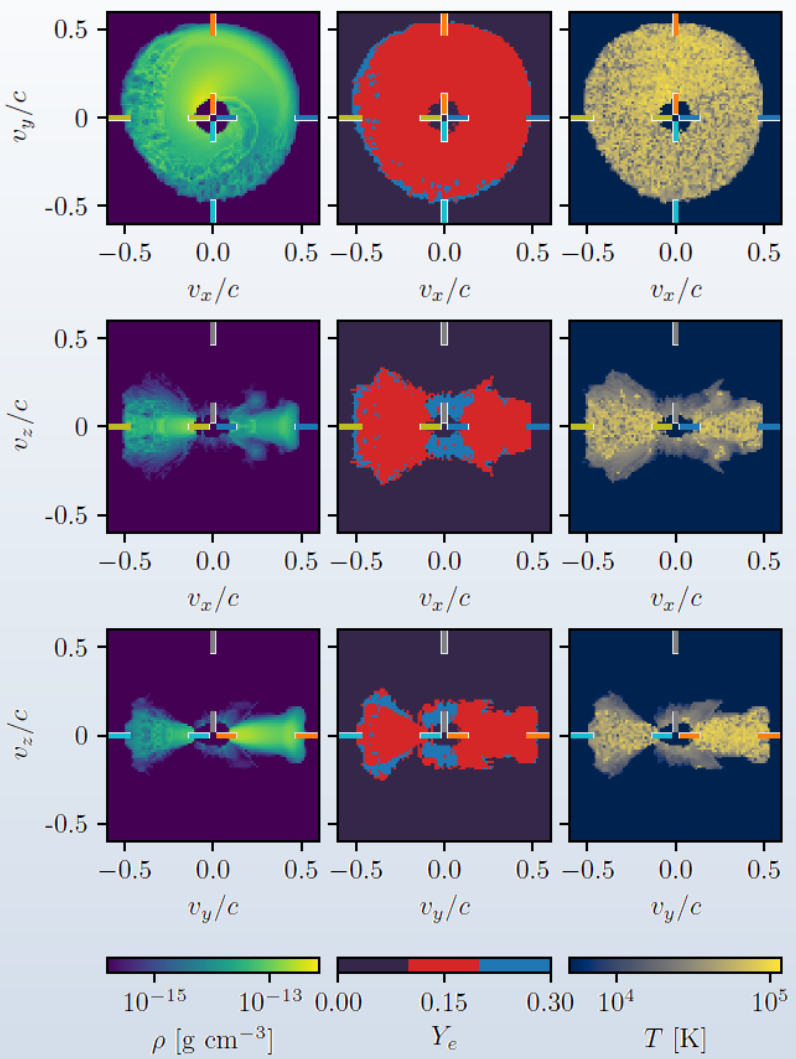
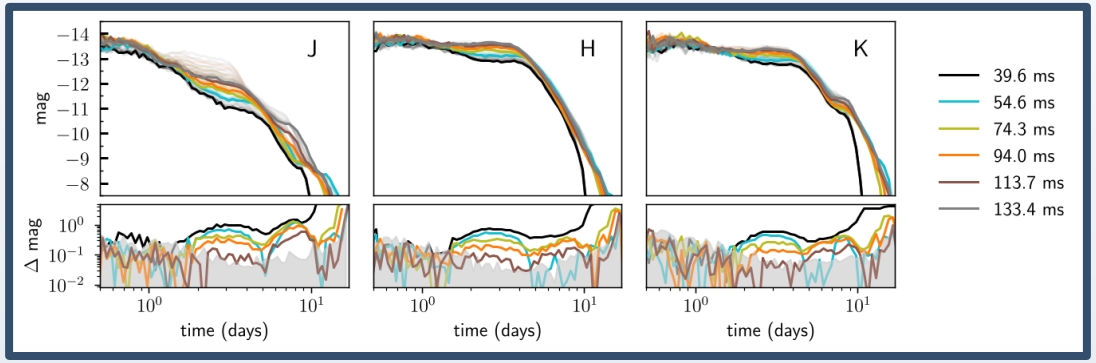


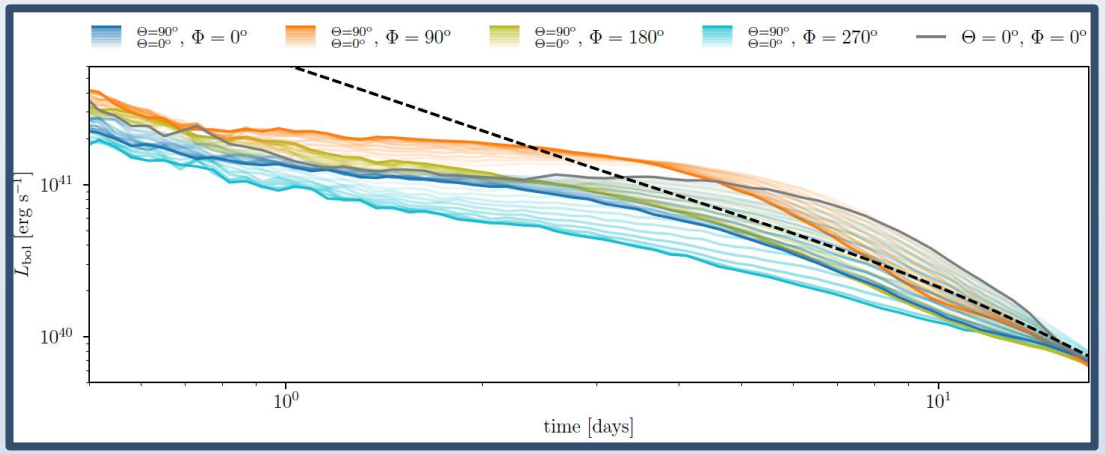


Markin et al. 2023
(accepted in: *Phys. Rev. D*)

- careful with assumptions:
  - homologous expansion
  - spherical / axial symmetries

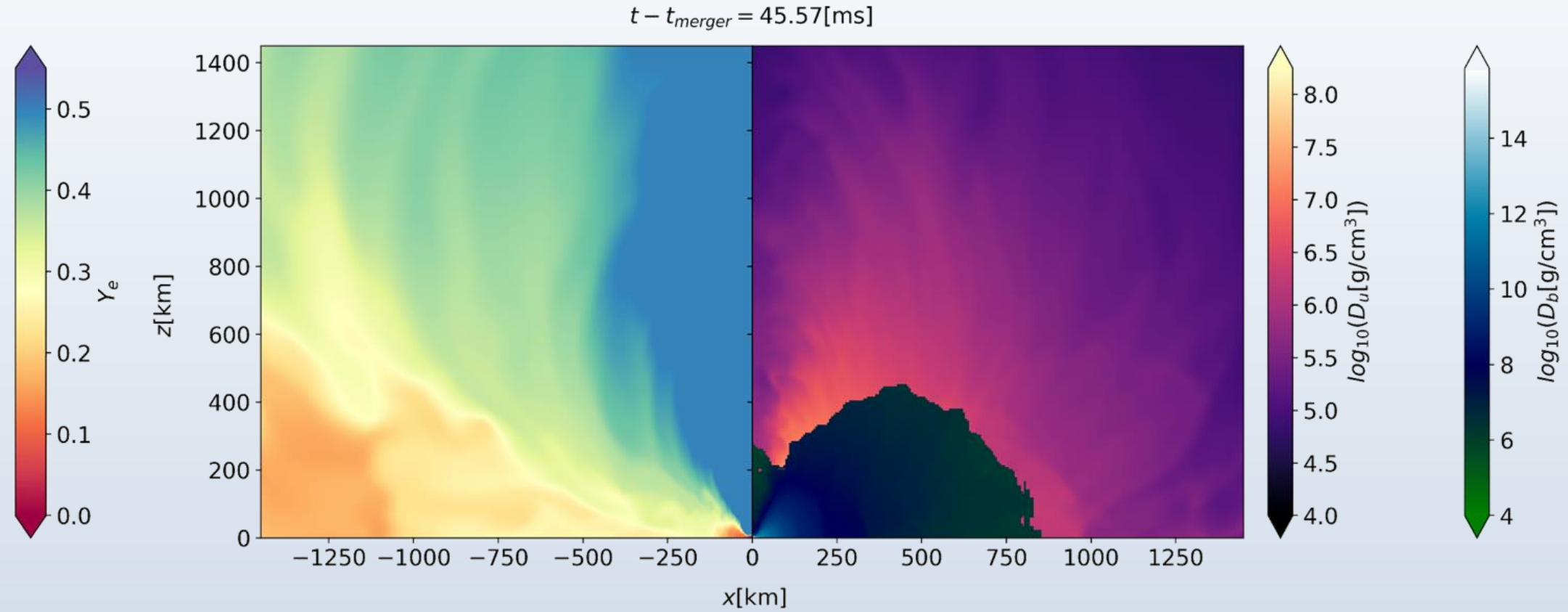
- need long-term and accurate numerical-relativity simulations
  - microphysics
  - neutrinos
  - magnetic fields





Thank you for your Attention!

Simulations with Neutrino Transport



Schianchi et al. 2023
(accepted in: *Phys. Rev. D*)

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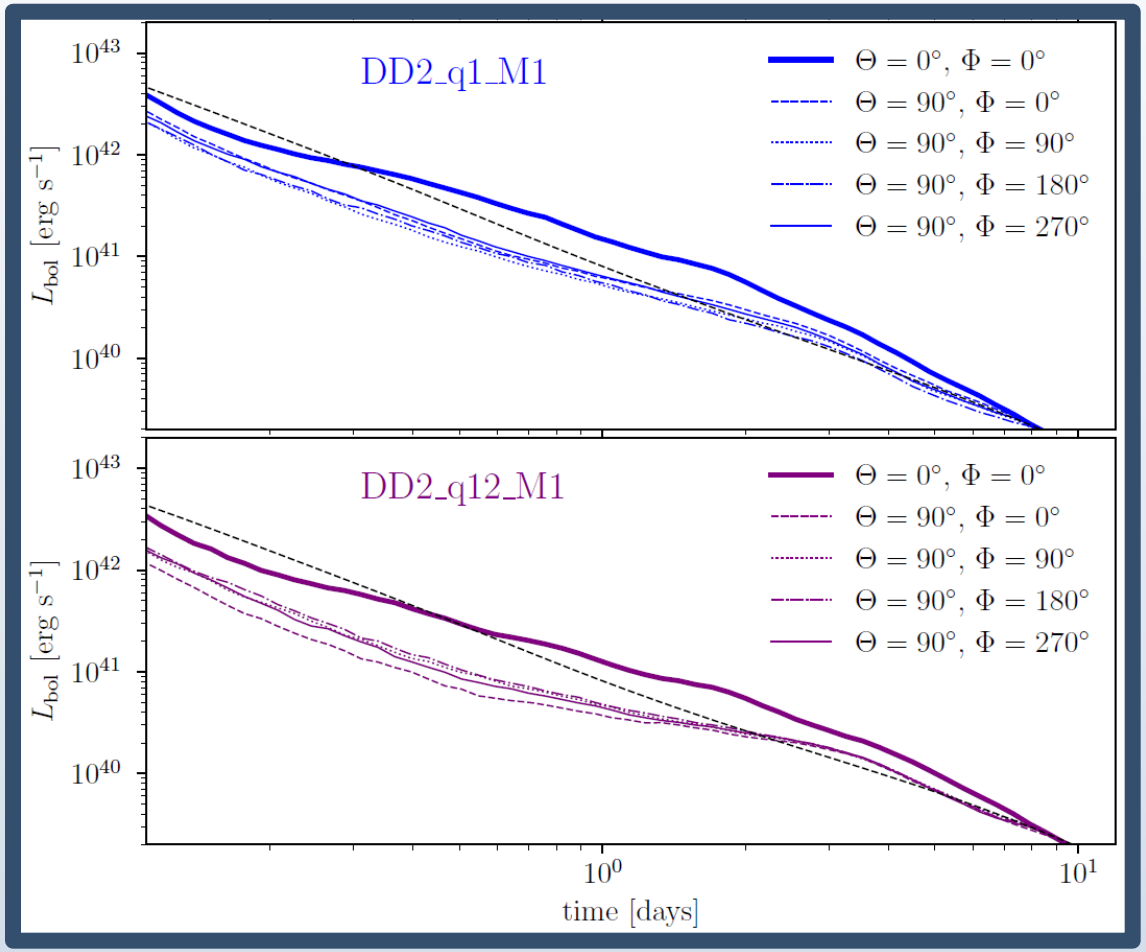

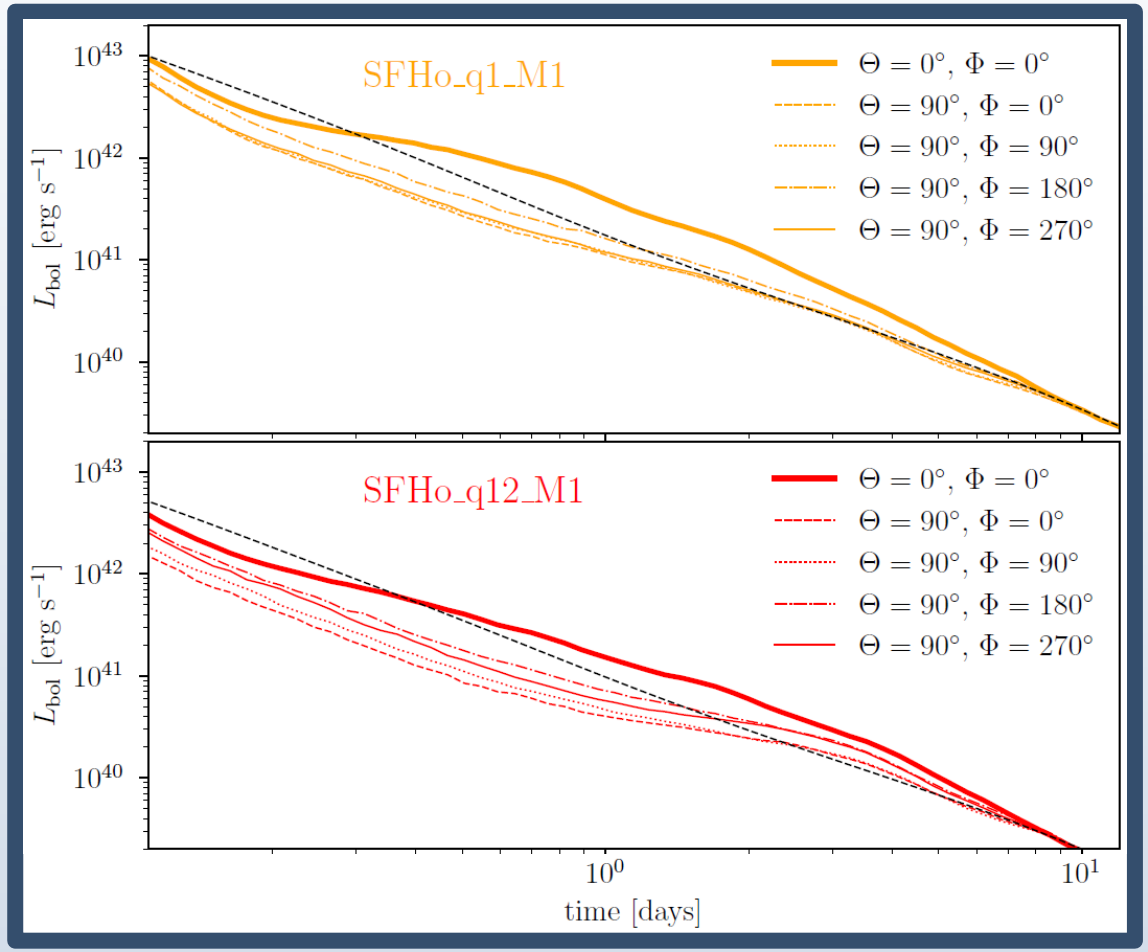

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