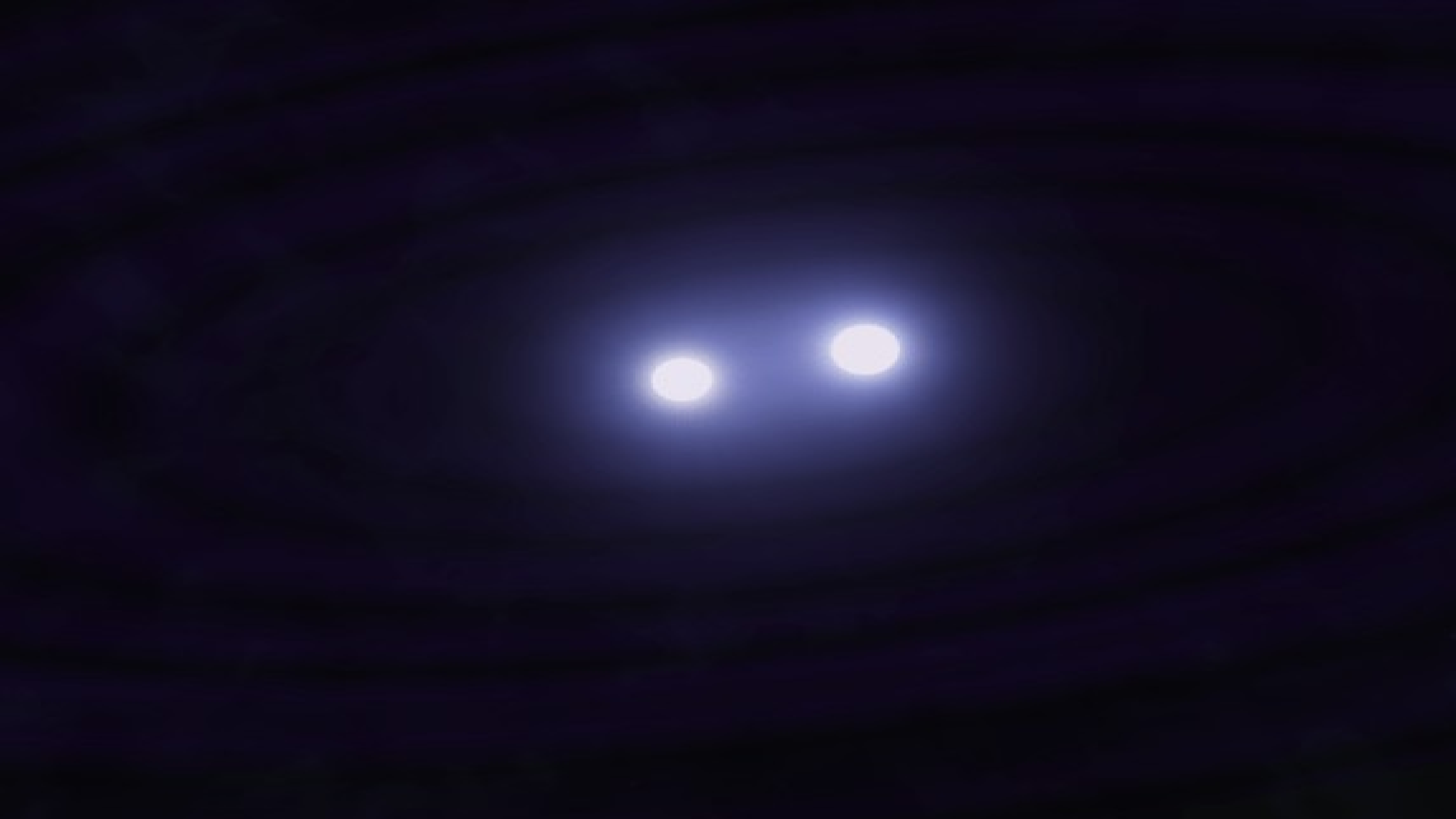


RIT

Spiral-wave Wind for the Blue Kilonova (arXiv:1907.04872v2)

Authors: Vsevolod Nedora et. al.

Journal Club

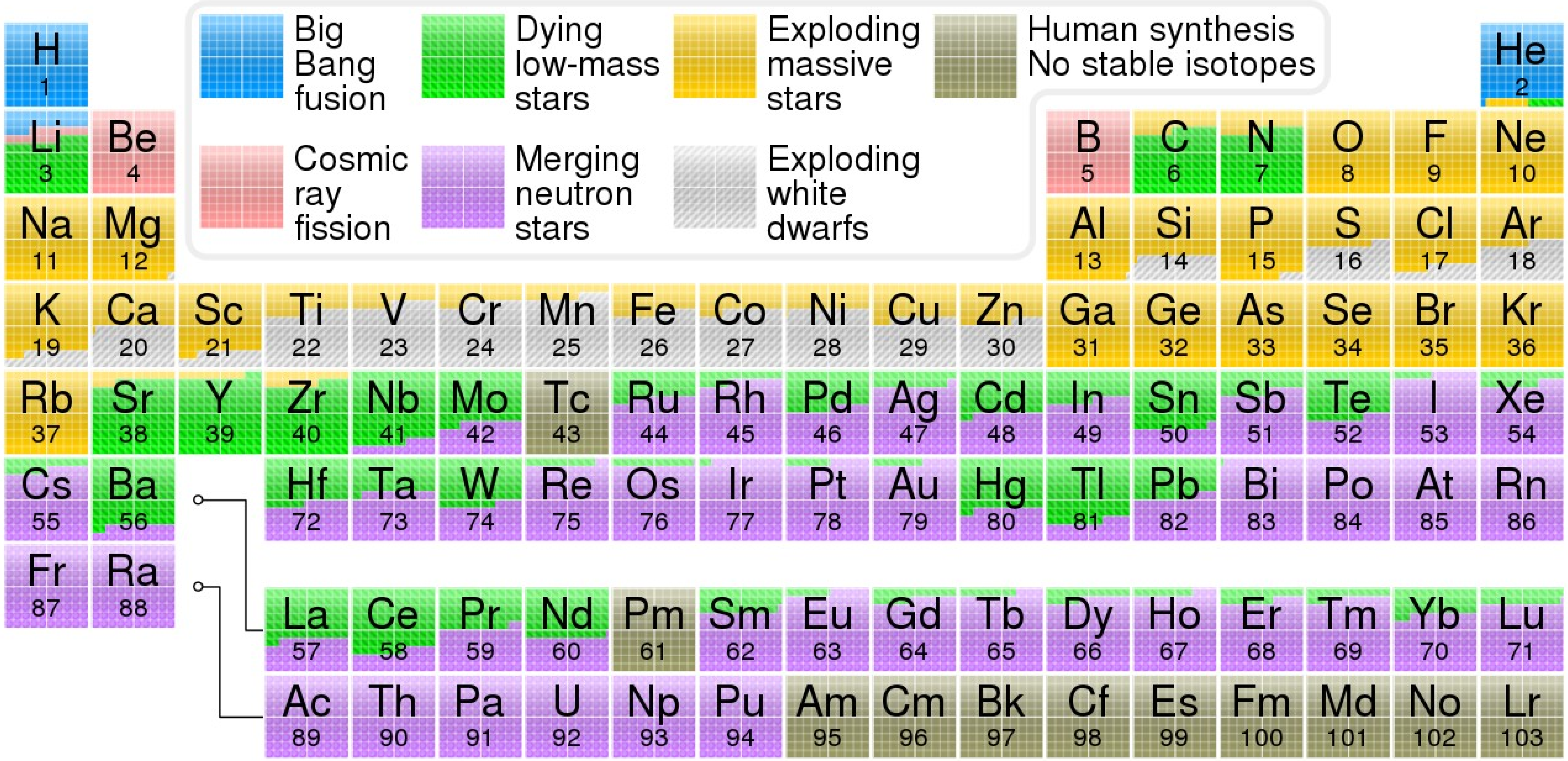
Presented By: A. H. Fernando

Motivation

The motivation behind this paper is to make steps towards understanding the hydrodynamics that can power blue kilonova.

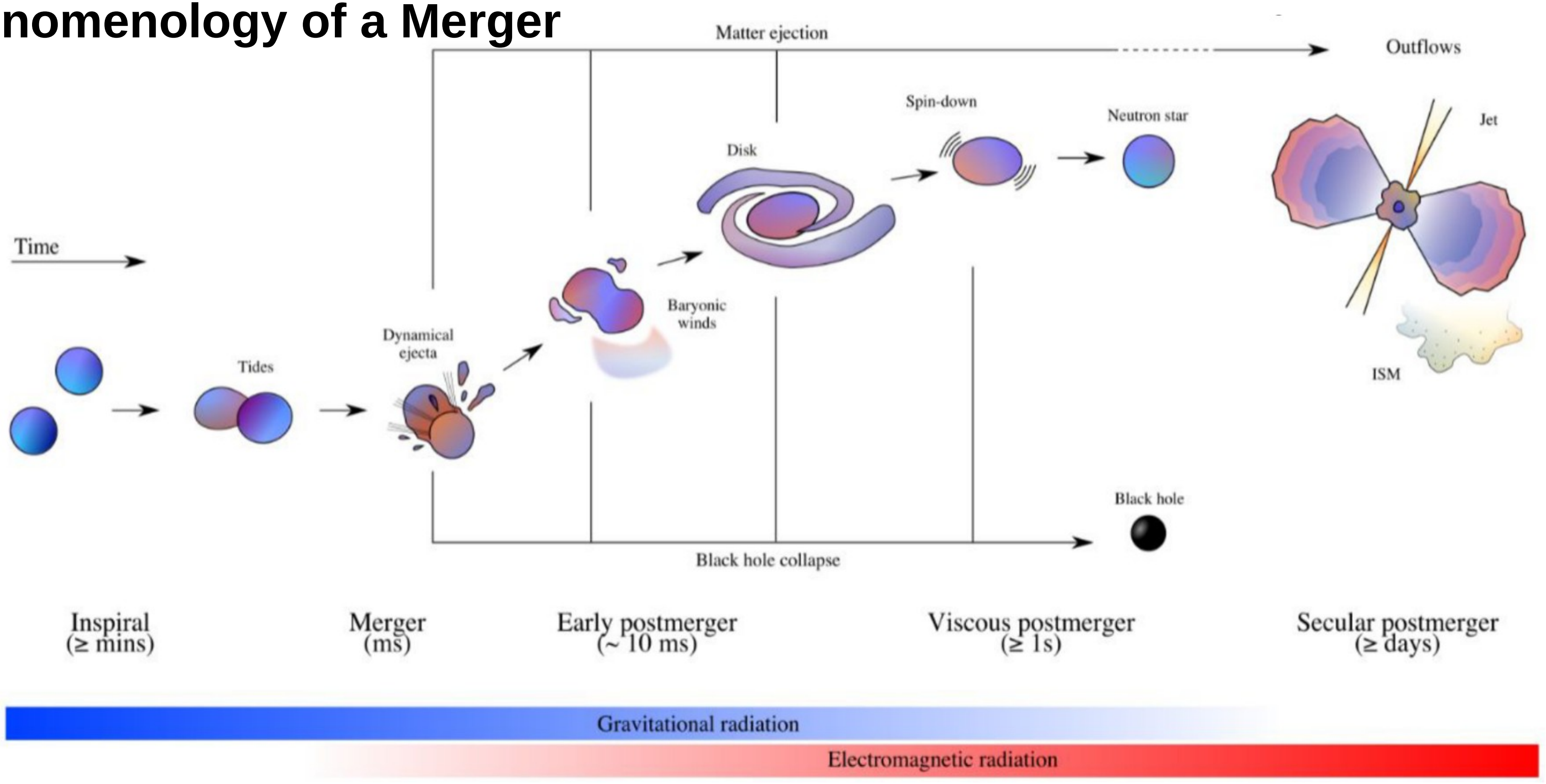
Introduction

- **Binary neutron star mergers: possible source of r-process**



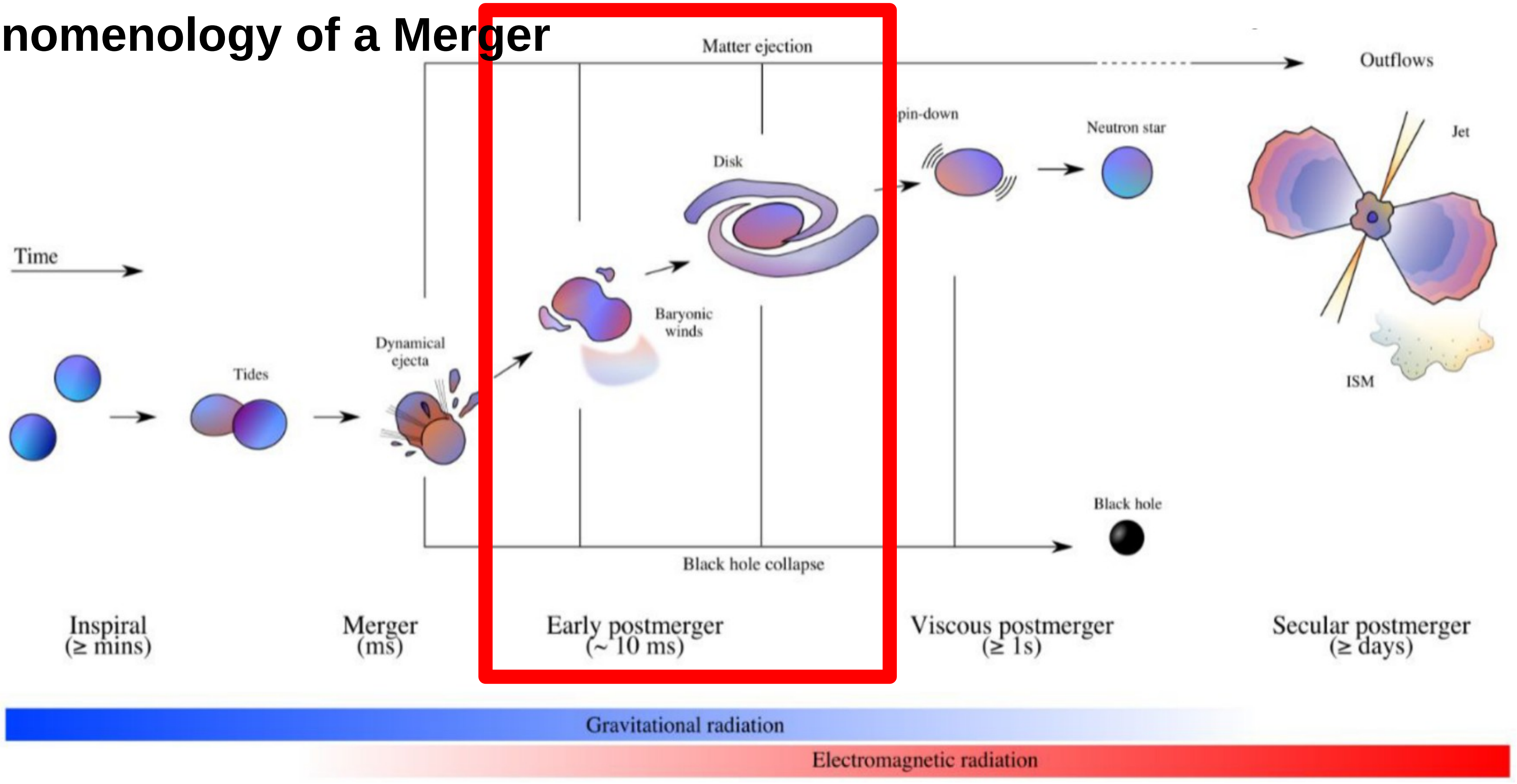
Introduction

- **Phenomenology of a Merger**



Introduction

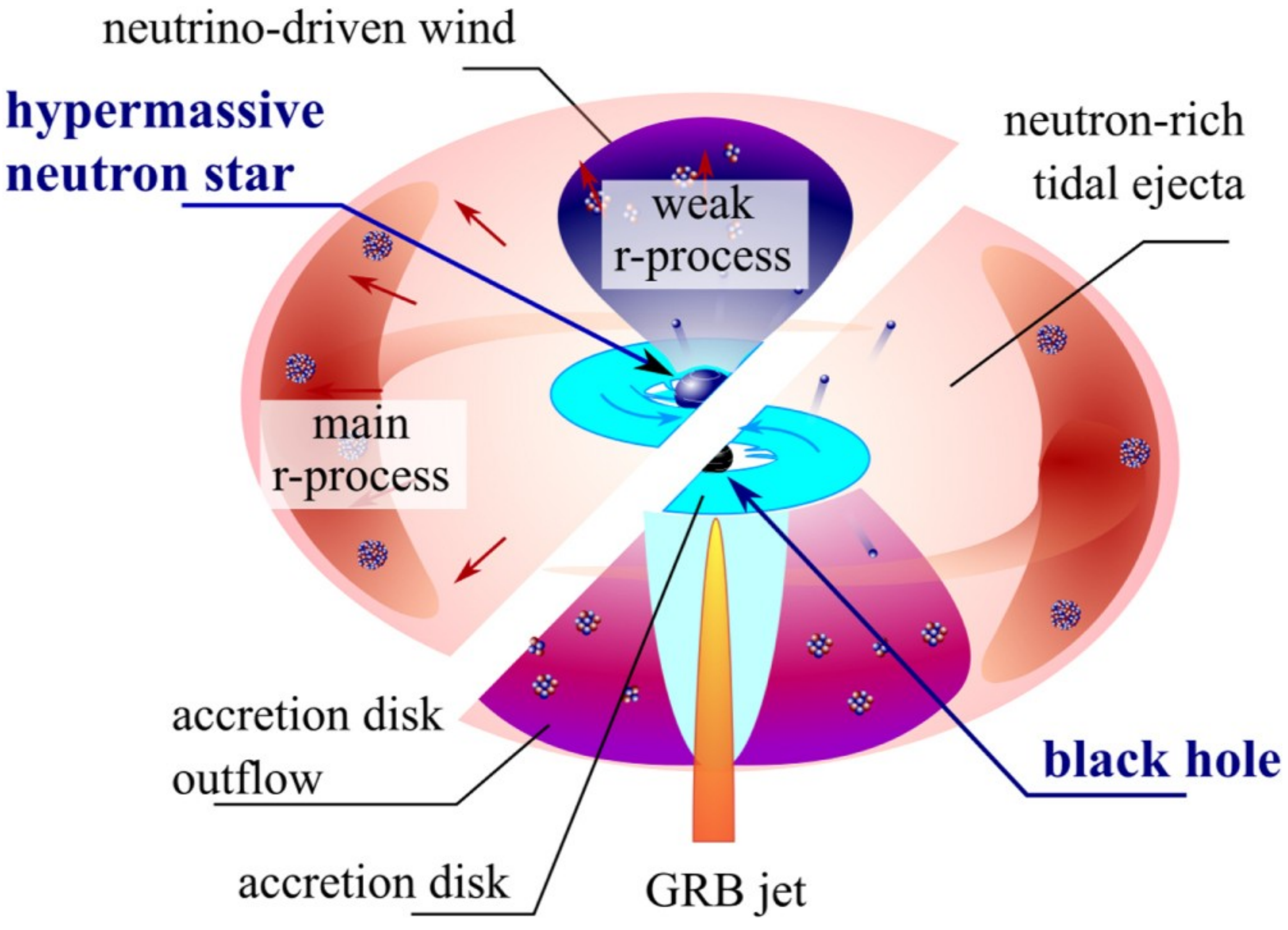
- **Phenomenology of a Merger**



Introduction

- **Observation of the kilonova AT2017gfo + GW170817**
  - **compelling evidence for being a primary site for r-process nucleosynthesis (Lattimer and Schramm 1974)**
- **EM radiation in the UV, optical, and NIR wavelengths**
  - **Driven by the radioactive decay of newly synthesized elements**

Introduction



(Korobkin et al. 2021)

Introduction

- KN light curve models need to account for
  - multiple ejecta (dynamical, wind, viscous, etc.),
  - the anisotropy of the ejecta composition,
  - the irradiation among the ejecta components
- Simulations largely agree with outflow properties inferred for AT2017gfo (Perego et al. 2017; Kawaguchi et al. 2018)
- The early blue kN however, remains a challenge
  - Simulations not producing ejecta with the large velocities and electron fraction (Fahlman and Fernández 2018)
- Authors propose a new generic hydrodynamics-driven mechanism – spiral-wave wind

Question Being Addressed

Provide a hydrodynamics-driven explanation for the blue kilonova phenomenon, focusing on the role of spiral arms in the remnant and their contribution to the observed light curves and nucleosynthesis processes.

Methodology

- Conducted 3+1 numerical relativity simulations
  - Binaries with masses of M = (1.364 + 1.364)$M_\odot$
  - EOS:
    - HS(DD2) (Typel et al. 2010; Hempel and Schaffner-Bielich 2010)
    - LS220 (Lattimer and Swesty 1991)
  - Model evolution from 30 ms up to 100 ms

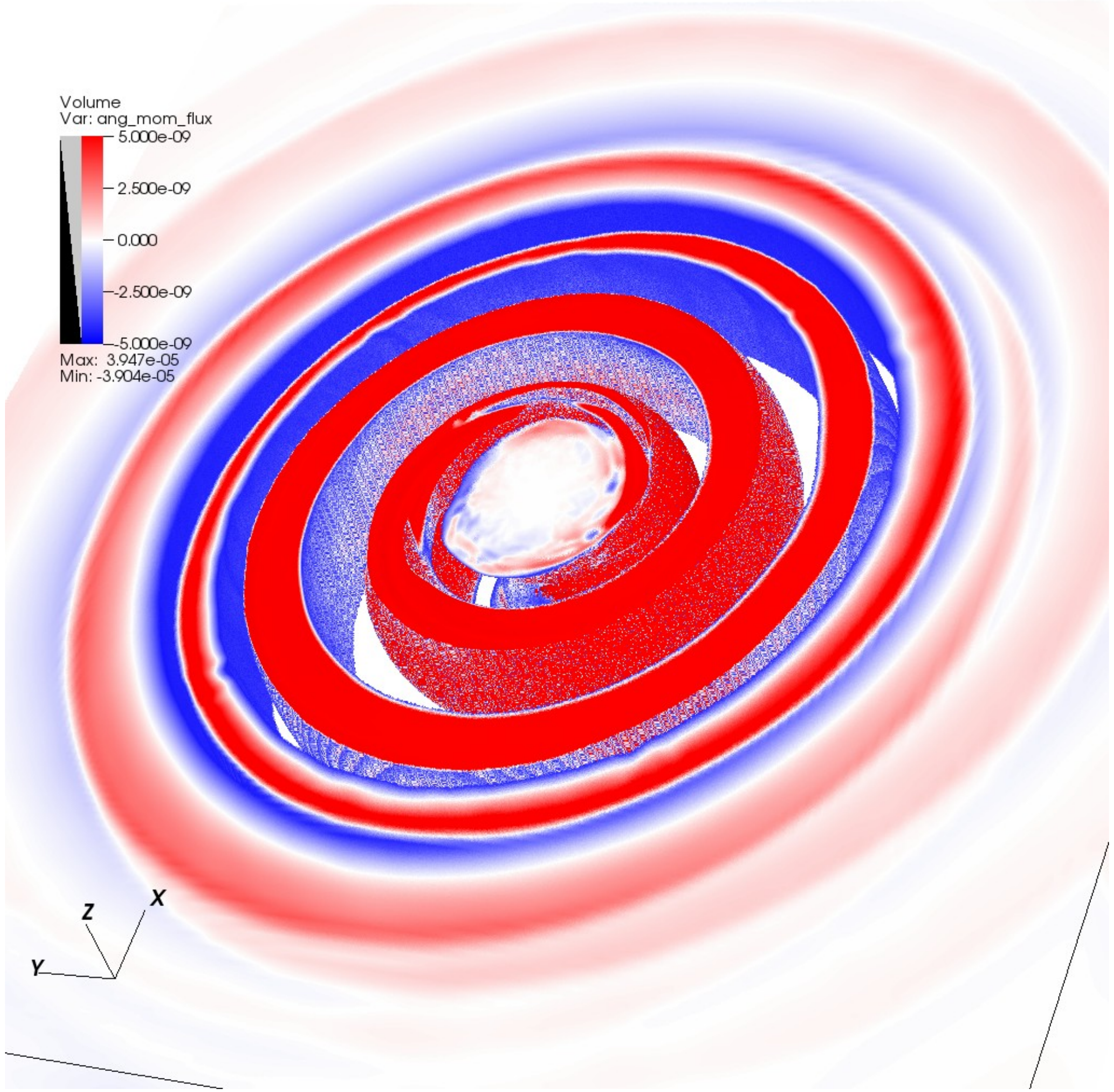
Methodology

- **Simulations performed using WhiskyTHC code (Radice and Rezzolla 2012; Radice et al. 2014a,b, 2018c)**
- **Allows for the treatment of turbulent viscosity using the general-relativistic large eddy simulations method (GRLES) (Radice 2017)**

Methodology

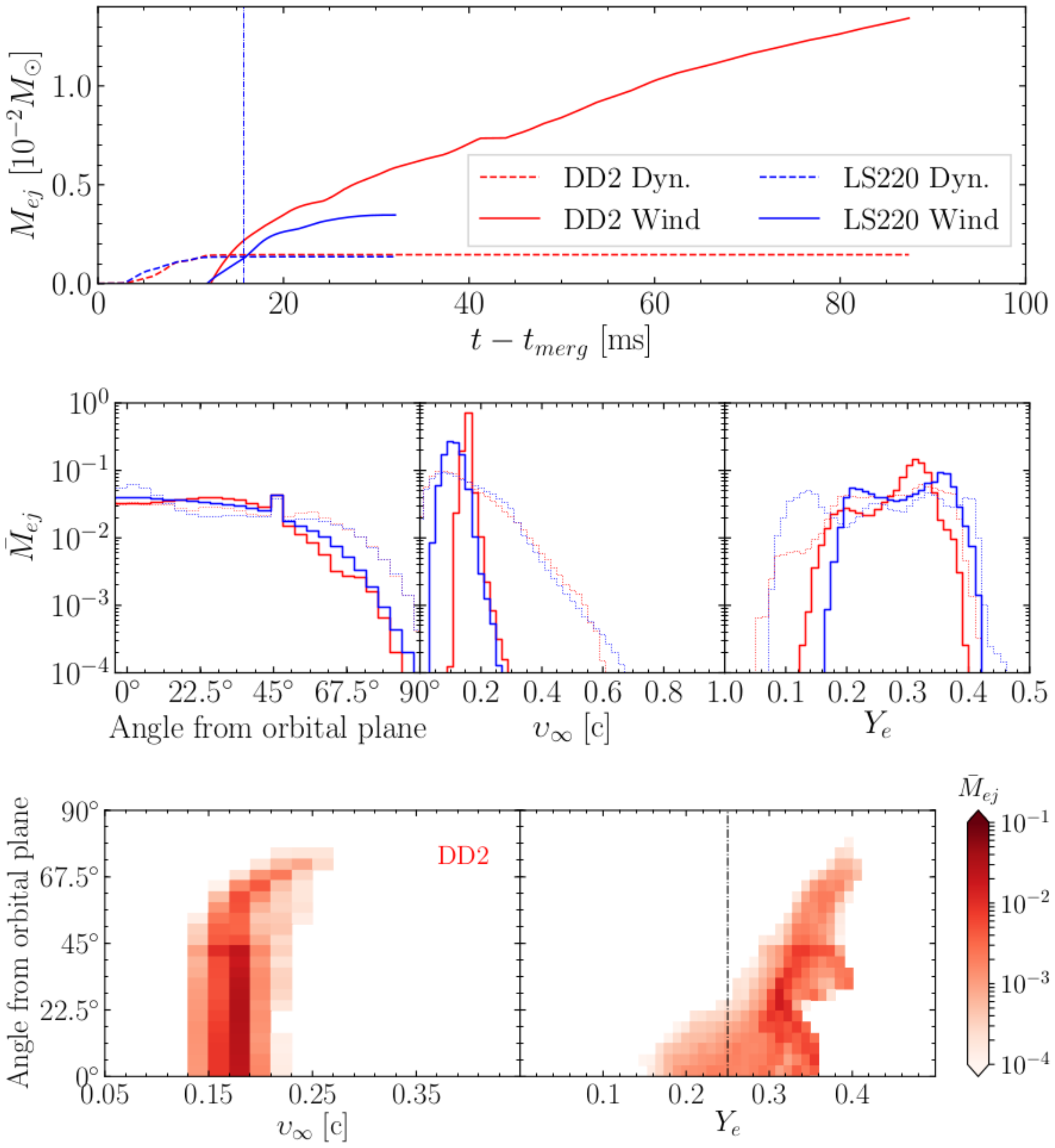
- Ejecta are calculated on coordinate spheres at r = 294 km
  - Using the geodesic criterion for the dynamical ejecta (Radice et al. 2018a).
- Wind has steady-state flow,
  - Bernoulli criterion was used
- From the fluid's stress energy tensor, the angular momentum density flux was computed
- r-process nucleosynthesis yields were computed using method detailed in (Radice et al. 2018a).

Results



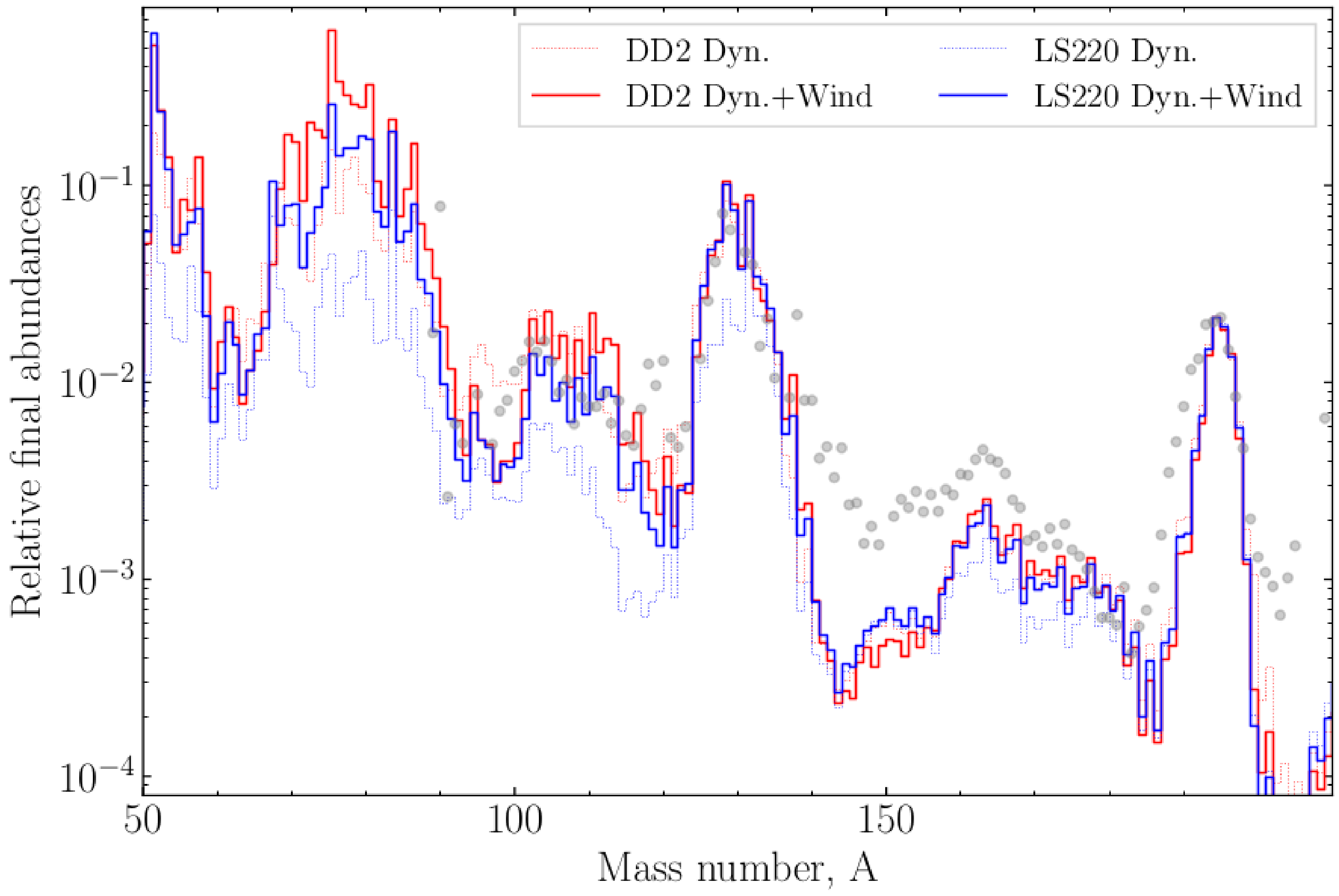
(Nedora et al. 2019)

Results



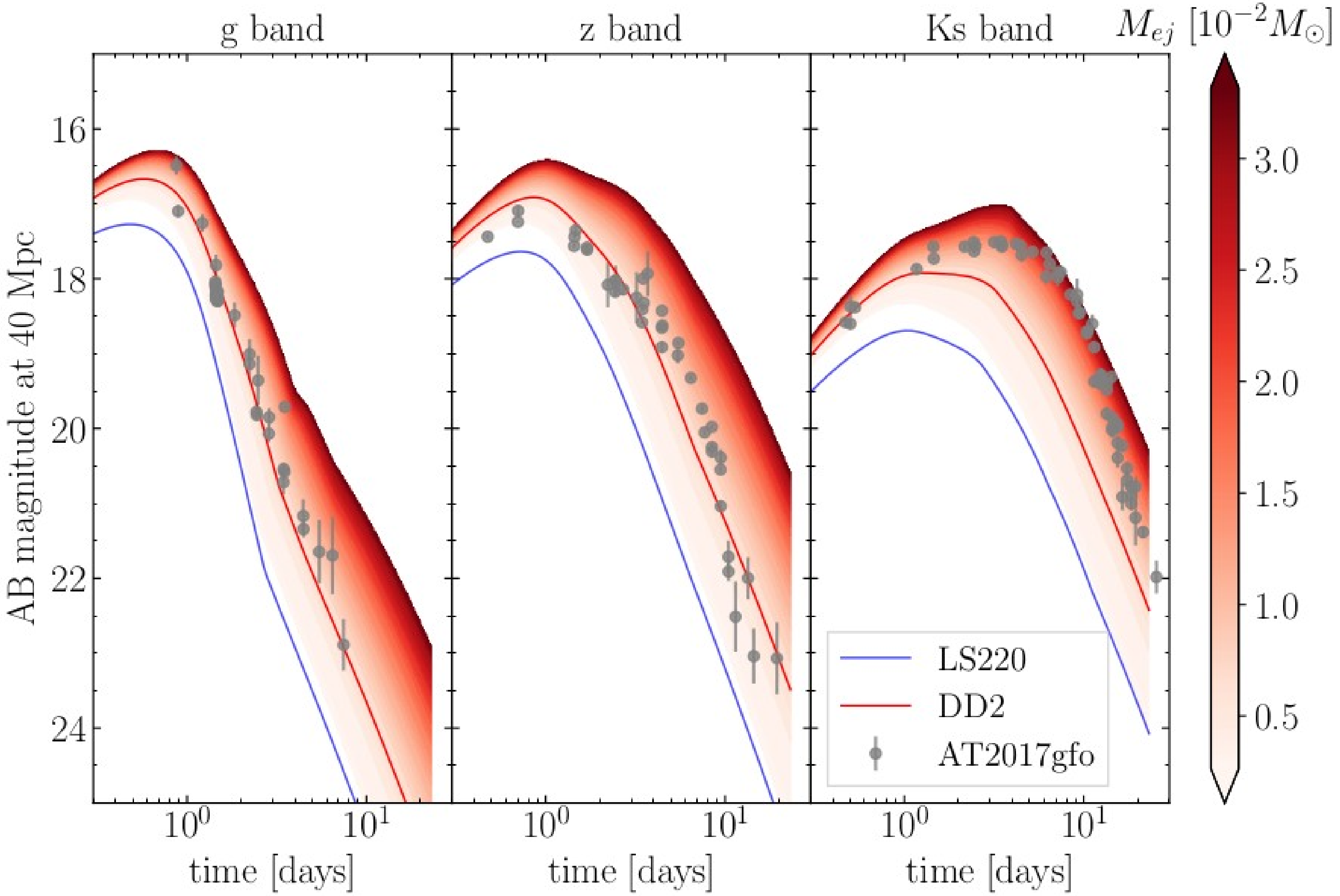
(Nedora et al. 2019)

Results



(Nedora et al. 2019)

Results



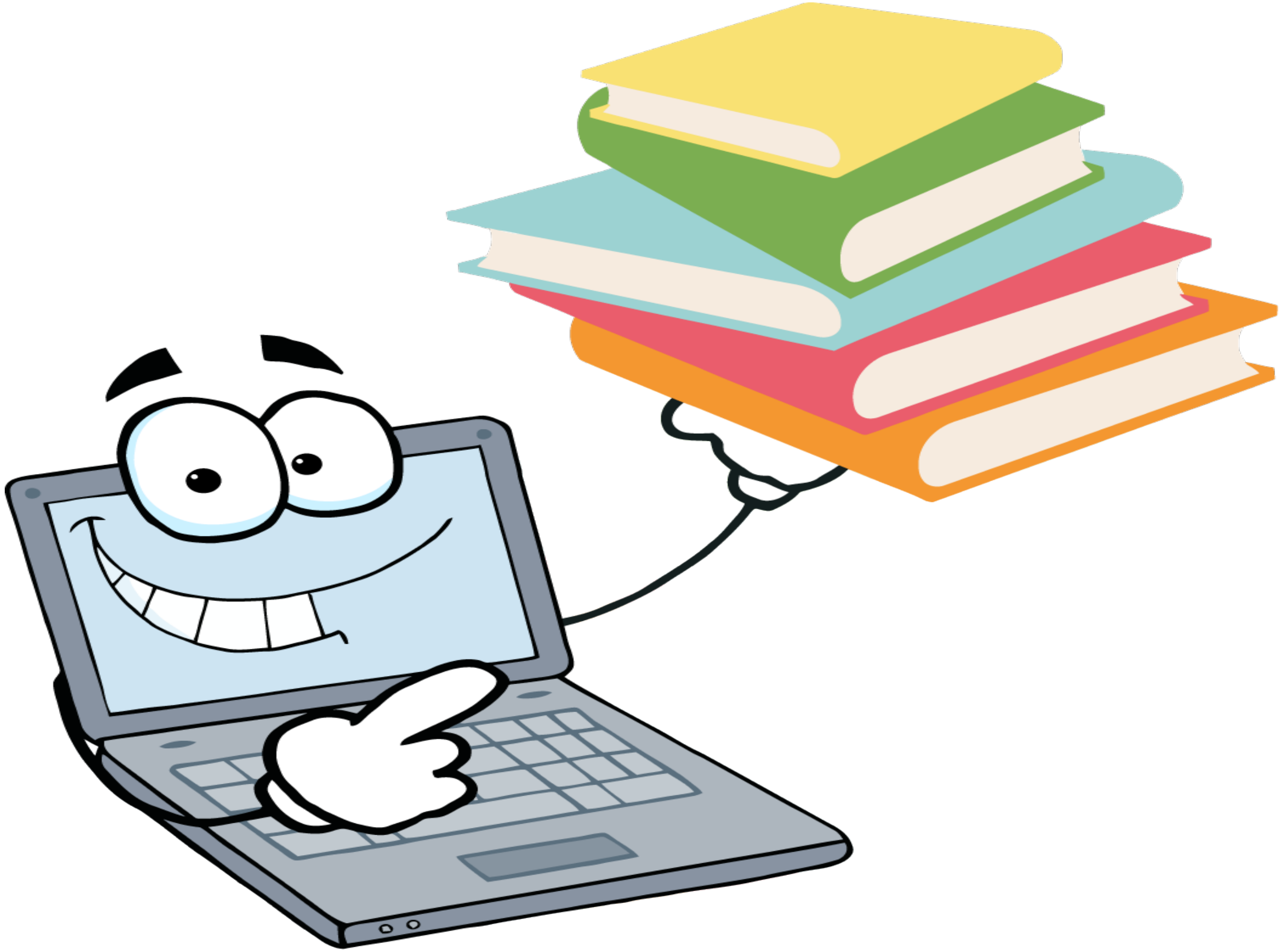
(Nedora et al. 2019)

Summary

Summary

- **Standard kilonova models applied to the early AT2017gfo light curve exhibit discrepancies with simulations**
- **Alternative explanations**
  - **contradict current simulations and observations (e.g. jets) (Bromberg et al. 2018; Duffell et al. 2018)**
  - **or necessitate the existence of extensive strong magnetic fields that may not be generated post-merger (Metzger et al. 2018; Fernández et al. 2019; Radice et al. 2018d; Ciolfi et al. 2019).**
- **The authors identified a robust dynamical mechanism for mass ejection that explains early-time observations without requiring any fine-tuning.**
  - **Nucleosynthesis is complete, produces all r-process elements in proportions similar to solar system abundances.**
- **Further work: include better neutrino-radiation transport and magnetohydrodynamic effects (Siegel and Metzger 2017; Fujibayashi et al. 2018; Radice et al. 2018c,a; Miller et al. 2019).**

References



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Thank you

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