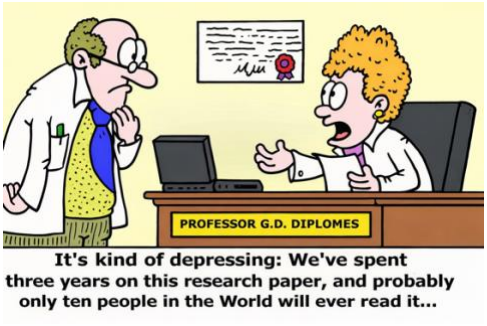
Paper Assignment 2



Read and study **one** of the following papers:

Theoretical papers on the impact of binaries

- Binaries and rotation: De Mink et al. 2013, *The Rotation Rates of Massive Stars: The Role of Binary Interaction through Tides, Mass Transfer, and Mergers*
- Mergers evolution, Schneider et al. 2021, stellar evolution of a modeled of binary merging product.
- Common envelope: Kruckow et al. 2016, Common envelope evolution in massive binary stars

Observational papers on the binary fraction

- Sana et al. 2025, *A high fraction of close massive binary stars at low metallicity*
    - Note, this is a paper in *Nature Astronomy* Journal, so it has a different structure.
- Or Villaseñor et al. 2025: *BLOeM survey, early B-type stars in the SMC,* a good recent paper on B-type star multiplicity. (I would suggest not to have both this and the Sana et al. paper selected)

Compact-object binaries

- Double neutron stars from binary population synthesis: Chattaraj et al. 2025, *Forming Double Neutron Stars using Detailed Binary Evolution Models with POSYDON: Comparison to the Galactic Systems*. A paper on the use of binary evolution in big populations, to try to understand the statistical properties of double compact objects, such as double neutron stars.

Instructions for paper reading:

- While reading a paper, begin with the **title and abstract**, and read them carefully, more than once if needed. They provide the central question, the scope of the work, and the main result, which will guide your reading of the rest of the paper. After that, it is often helpful to read the

conclusions before moving to the full body of the text, because this gives you a clear sense of what the authors claim to have found.

- If you are new to the field, or still developing experience with reading scientific papers, it may be better to read the **introduction** before the conclusions. The introduction usually defines important terminology and sets the scientific question and the motivation to answer it. This can make the rest of the paper much easier to follow.
- When reading the **methods** section, focus on the high-level methodology. Your goal is to understand what the authors did, why they chose that approach, and what main assumptions they made, without getting lost in technical details that may only be necessary for someone attempting a full reproduction of the work. As you gain more experience, you should increasingly aim not only to follow the method, but also to evaluate whether it is appropriate and convincing (especially in your field).
- In your presentation, try from the very beginning to give a **one-sentence summary of the main outcome of the paper**, without going into details. This helps your audience immediately understand the central result and provides a framework for everything that follows. And it helps you actually to test yourself if you can summarize the paper in one sentence! ☺

Instructions for figures studied and presented:

- Understand first the axes and their physical meaning. For example, in our stellar models, figures often show either time-evolution plots, that is, stellar tracks describing how a parameter changes with time, or snapshot profiles, that is, how a parameter changes with position inside the star at a given time. In papers, you will of course encounter more varied and complex figures, but the first step is always to identify what is being plotted and what physical quantity each axis represents.
- Understand the main trend of a curve before focusing on smaller details. Ask why the y-values increase or decrease as the x-axis changes, what physical reasoning explains this behavior, and in which direction the plot should be read, for example left to right or as an evolutionary sequence. It is often best to focus on one curve first, to understand the basic behavior, before comparing different curves within the same figure. Focus on the dominant trend first, and only then on smaller irregularities or features, which are often secondary complexities superimposed on the main behavior. For example, in a snapshot profile of the internal temperature of a star, the temperature generally increases as one moves deeper into the star, whereas in the core of a very evolved massive star neutrino cooling may alter or even reverse this trend.
- Consider the absolute values on both the x- and y-axes. Ask whether they make physical sense, whether they are consistent with order-of-magnitude expectations, and whether any values appear surprising or require further thought.

Expected outcome of the assignment

- Makes few slides with the main plots and conclusions of the paper. As mentioned above, try to present a one-sentence and the main conclusions of the paper, even better shown on the main plot of it. If the plots are many, no need to show all of them, you select what to show of the paper.
- Aim to present to the whole class. Aim for 15-minute presentations, if not interrupted (which you will as you realized). ☺
- Deadline and presentation date: **11^{th} of May**