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New Class of Laboratory Astrophysics Experiments: Application to Radiative Accretion Processes Around Neutron Stars

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Neutron stars are subject to intense X-ray bursts [1], interacting with their surrounding accretion disks [2,3]. This complex process has yet to be completely understood. In given conditions, this strong radiation leads to the propagation of radiatively driven supersonic heat waves [4] (RDSHWs) in the accretion disk. As for now, the macroscopic properties of its inner regions cannot be properly inferred from observational data. Theoretical models also struggle to describe it rigorously. Meanwhile, laboratory astrophysics allows us to obtain new data to improve the astrophysical models thanks to the similitude theory [5]. To use this classical approach on the burst-disk interaction, a currently unreachable laser energy would be required. In order to overcome this constraint, we adapted an extension of similitude concept called equivalence symmetries [6]. These new powerful tools enable us to demonstrate the feasibility of a theoretical link between laboratory plasmas and astrophysics radiative processes in different physical regimes. This approach constitutes the first step towards the creation of an experimental platform called MaTaLE (Mapping Theory and Laser Experiments) focusing on these new innovative symmetry approaches for laboratory astrophysics.

In this poster, we will focus on using the obtained equivalence symmetries to produce an experimental setup able to mimic the astrophysical system, and aiming to study RDSHWs astrophysical properties. This experimental design will be supported by 2D FCI2 numerical simulations. This will allow us to test for the first time the validity of numerical simulations from the astrophysical radiation hydrodynamics code RAMSES-RT [7] in unexplored radiative regimes. These results constitute the starting point of a new general approach expanding the catalog of astrophysical systems studied on laboratory scales [8].

References

[1] Galloway & Keek [in Timing Neutron Stars: Pulsations, Oscillations and Explosions, **209-262**, Springer, (2021)]

[2] Ballantyne & Everett [ApJ, **626**, **364**, (2005)]

[3] Fragile *et al.* [Nature Astronomy, **4**, **541** (2020)]

[4] Marshak [Physics of Fluids, **1**, **24**, (1958)]

[5] Falize *et al.* [ApJ, **730**, **96**, (2011)]

[6] Ovsiannikov [Academic Press, (1982)]

[7] Rosdahl & Teyssier [MNRAS, **449**, **4380**, (2015)]

[8] Tranchant *et al.* [ApJL soon to be submitted, (2022)]