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Overview of Laboratory Astrophysics experiments at LULI

M. Koenig[1,9], B. Albertazzi[1], Th. Michel[1], G. Rigon[1], P. Mabey[1], J.R. Marquès[1], A. Casner[2], V. Bouffetier[2], C. Michaut[3], S. Laffite[4], E. Falize[4], L. Van Box Som[4], J. Ballet[5], Y. Sakawa[6], T. Sano[6], H. Shimogawara[6], R. Kumar[6], R. Kodama[6], A. Faenov[7,12], T. Pikuz[7,12], N. Ozaki[8], Y. Kuramitsu[8], T. Morita[9], G. Gregori[10], J. Menecke[10], P. Tzeferacos[11], D. Lamb[11], S. Ryazantsev[12]

[1] *LULI - CNRS, École Polytechnique, CEA, Université Paris-Saclay, UPMC Univ Paris 06 : Sorbonne Universités -F-91128 Palaiseau cedex, FRANCE*
[2]*Université de Bordeaux-CNRS-CEA, Centre Lasers Intenses et Applications, UMR 5107, F-33405 Talence, France*
[3]Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange, France
[4]*CEA-DAM-DIF, F-91297 Arpajon, FRANCE*
[5]*CEA-DRF, IRFU, FRANCE*
[6]*Institute of Laser Engineering, Osaka University, Suita, Osaka 565-0871, JAPAN*
[7]*Open and Transdisciplinary Research Initiative, Osaka Uni versity, Osaka, 565 -0871, JAPAN*
[8]*Graduate School of Engineering, Osaka University, Suita, Osaka, JAPAN*
[9]Department of Energy Engineering Science, Faculty of Engineering Sciences, Kyushu University, JAPAN
[10]Department of Physics, University of Oxford, Oxford, UK
[11] Flash Center for Computational Science, University of Chicago, IL 60637, USA
[12]Joint Institute for High Temperature RAS, Moscow, 125412, RUSSIA

e-mail (speaker): michel.koenig@polytechnique.edu

For more than two decades, we have performed laboratory experiments in connection with astrophysical phenomena or object. In particular, we pay a dedicated attention to several key processes that step in the supernovae explosions physics: from radiative shocks occurring at early stage of the SNR, to the "final" Sedov phase through the Rayleigh-Taylor instability phase.

In this talk, recent experimental results on radiative shocks (RS) interacting with solid obstacles, hydrodynamics instabilities (RTI) and blast waves that play a major role in astrophysical fluid dynamics will be presented.

Radiative shocks (RS) are phenomenon widely observed in astrophysics, for example in supernovae remnants or accretion processes. here, we will present new data on highly radiative shocks generated in a low-density gas filled cell obtained on the GEKKO XII laser facility. The RS was generated by using an ablator-pusher target (CH/Sn or CH/Au/Ti), designed to limit as much as possible the preheating produced by the hot corona. The propagation media is Xe or He gas, with the aim to compare radiative effect in each medium. High velocity RS have been generated (100-140 km/s) [1]. Dimensioning for LMJ shots to be performed in 2020 will be discussed.

Regarding the instabilities, they might be responsible of the absence of spherical symmetry in the shape of the Supernova Remnant, and might affect the dissipation of the energy. Here, models are often not accurate enough, as even the late-time behavior of a single-mode RTI is not well-known. In this context we performed experiments on LULI2000 laser facility, in order to deepen our knowledge on highly non-linear RTI. Recent results with monomode and bimode targets [2] as well as with different Atwood numbers will be presented.

Finally, when two isolate massive stars are relatively closed and exploded, the resulting SNRs can interact and lead to more complex structure of the ISM. The impact zone presents a fascinating complex hydrodynamic physics which depends on the age of SNR, its relative evolution stage and the relative position of the two stars. In this talk, I will present an experiment performed on LULI2000 where this astrophysics situation was mimicked by generating two strong blast waves in the laboratory. We did measure all possible variables involved in their mutual interaction in a first phase, with a spherical object in a second phase. Different gases (N, Ar, Xe) were used as propagation medium and their impact on the interaction zone will be discussed.

In all cases, 2D radiative hydrodynamic simulations were performed with the FLASH code developed at U. Chicago.

References

[1] Th. Michel et al., HPLSE Vol6. (2018) e30
[2] G. Rigon et al., Submitted to Phys Rev E