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Relativistic hydrodynamics. (English)
[B] Oxford: Oxford University Press. xv, 735~p. ~55.00 (2013). ISBN 978-0-19-852890-6/hbk

This is an excellent modern monograph that offers the beautiful realm of relativistic (R) fluids (F), at once serving a short repetition of fundamental notions viewed from the general relativity (GR) viewpoint and pushing the limits towards the present-day working methods. As to my impression, these multiple aims are realized, we have an exceptionally usable monograph that contains nearly everything of the important modern results embedded in the classical theory. This is more so since the authors are active scientists working actually in this domain.
The volume is organised in three parts. The first part concerns the physics of R hydrodynamics. It begins with a review of the methods of GR used in the description (mathematical questions of flat and curved spacetimes, Einstein equations, spacetimes of astrophysical importance and gravitional radiation). Then the authors present the kinetic description of fluids in general and the concept of the equation of state. The R perfect fluids (general theorems of fluid flow) are examined reaching the problem of interacting perfect multifluids. In the following, the authors treat the linear and nonlinear hydrodynamic (H) waves, the Riemann problem, the questions of jumps, the stability of shock waves and the discontinuities in GR. The next paragraph deals with the detonations and deflagrations. Then the authors discuss the non-perfect fluids, starting from the energy-momentum tensor and reviewing the classical and extended theories of irreversible processes.
The second part envisages the numerical procedures applied in RH. Here, the different formulations of the Einstein-Euler equations are first introduced. Then the finite difference methods are reviewed. The next chapter is devoted to the numerical H and the high-resolution shock capturing methods. Then the higher-order methods are reviewed.
The third part is devoted to applications and cut into two chapters, treating the non-selfgravitating and selfgravitating fluids. In the first chapter, the authors consider the similar and non-similar flows, the R blast waves, the spherical and non-spherical accretion onto and out of a compact object, the circular motion around a black hole, the geometrically thick tori, the R accreting discs, the R jets and R heavy-ion collisions. In the second chapter, the RH of selfgravitating fluids is discussed (spherical stars, gravastars, rotating stars, the collapse of a compact star to a black hole and the dynamics of binary neutron stars).
A series of useful appendices ends the book (the geometrised system of units used throughout the book, the notable thermodynamic expressions, and important tensors are given in a concise manner). Finally, two appendices deal with the common practices in numerical RH and with the numerical building blocks. A rich list of references (38 pages) contains also 15 articles of the first and 6 of the second author. At the end of each chapter, the reader can find instructions for further reading together with problems to be solved.
The reviewer believes that not only are the authors to be congratulated for the content and composition of the book, but also the printing house for the excellent presentation of this remarkable book.
[Iván Abonyi (Budapest)]
MSC 2000:
- *76-02 Research monographs (fluid mechanics)
- 76Y05 Nonclassical hydrodynamics
- 83C55 Hydrodynamics (general relativity)
- 83C57 Black holes

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