

Preface

Stellar winds are a common phenomenon in stars, from the dwarfs, like the Sun, to the hot supergiants, and including red giants with low surface temperatures. In fact, we can say that all stars lose mass during some periods of their lives, and the study of this phenomenon is one of the main aspects of modern astrophysics. In the case of the Sun and other dwarf stars, the mass loss rate is small, having a small effect on the stellar evolution tracks, but even in these cases other effects may be important, such as the influence of the solar wind on the communications in our planet. In the case of hot stars, or even for red giants, the observed rates can be significant, thus affecting sometimes drastically the evolution and outcome of these stars.

Stellar winds are hydrodynamic phenomena involving the flow of circumstellar gases, so that the basic hydrodynamic concepts are directly applied in the study of the winds and of the mass loss from the stars. Unfortunately, many students in the astrophysical courses are not familiar with the foundations of this discipline, which have to be studied at the same time as they are introduced to the observational evidences of stellar winds, theoretical models and especially the association of purely hydrodynamical phenomena with the radiative transfer in the outer atmospheres of the stars. In this way, the study of the stellar winds becomes excessive, which frequently limits the amount of material that can be taught in the courses on the winds or on stellar physics.

This little book aims at partially compensating for the lack of basic knowledge of the hydrodynamic principles of astrophysics students. It is not a complete course on hydrodynamics, its astrophysical applications and stellar winds, but just an introduction to these important aspects of stellar physics. The text originated from lecture notes of a graduate course on stellar winds presented in the last 20 years at the astronomy department of São Paulo University.

The book attempts to present the main basic hydrodynamics equations, with many examples and suggested exercises. In this way, it can also be used as an introductory hydrodynamics text for physics and related students, although its main goal – and the applications worked out – are essentially dedicated to stellar astrophysics. The basic principles of hydrodynamics have many astrophysical applications, as in gas dynamics or in the dynamics of galaxies and galaxy clusters,

so that the book is particularly useful for students of general astrophysics. Exercises and a basic bibliography are included at the end of each chapter, allowing a more complete understanding of the subjects treated in the book.

Some parts of the book were inspired by graduate courses given at IAG/USP along the years, especially those by professor J. A. de Freitas Pacheco, to whom I am indebted. Preliminary versions of the text were supported by the department chairpersons Beatriz Barbuy, Jacques Lépine, and Vera Jatenco. I am also indebted to Augusto Damineli for the spectrum of de P Cyg, to Rodrigo Campos for the images of the Sun, M27 and the Crab Nebula, to Graziela Keller, for the spectra of NGC 6905, and to all colleagues and students that have collaborated in the revision of previous versions of this book, particularly Vera Jatenco, for the many corrections and suggestions. Naturally, any remaining mistakes and omissions are of my own responsibility.

The present edition is a translation of the book originally published in 2005. A few mistakes have been corrected, the bibliography was updated, and several new examples and applications have been included, but the main goals of the original edition have been preserved.

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Hydrodynamics and Stellar Winds

An Introduction

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2014, XVII, 178 p. 30 illus., 2 illus. in color., Softcover

ISBN: 978-3-319-04327-2