Astrophys Space Sci (2013) 345:155–167
DOI 10.1007/s10509-013-1362-0

ORIGINAL ARTICLE

Eigenfrequencies of rotationally and tidally distorted white dwarf models of stars

Arvind Kumar Lal · Tarun Kumar · Ankush Pathania

Received: 20 July 2012 / Accepted: 4 January 2013 / Published online: 24 January 2013

Abstract In the present paper we have studied the eigenfrequencies of small adiabatic barotropic pseudo-radial and nonradial modes of oscillations of the white dwarf models of rotating stars in binary systems. In this work the methodology of Mohan and Saxena (in Astrophys. Space Sci. 113:155, 1985) has been used that utilizes the averaging technique of Kippenhahn and Thomas (in Proc. IAU Colloq., vol. 4, p. 20, 1970) and certain results on Roche equipotential as that given by Kopal (in Advances in Astronomy and Astrophysics, Academic Press, 1972). The objective of this study is to investigate the effects of rotation and/or tidal distortion on the periods of oscillations of rotationally and/or tidally distorted white dwarf models of stars assuming it to be the primary component of the binary system and rotating uniformly. The results of present study show that the eigenfrequencies (both radial and nonradial modes) of the rotationally distorted and rotationally and tidally distorted white dwarf model of stars in binary systems tend to decrease under the influence of rotational distortions and rotational and tidal distortions, respectively. However, results are contrary for tidally distorted white dwarf model of stars.

Keywords Binaries: close · Stars: oscillations · Stars: rotation · White dwarfs

A.K. Lal · A. Pathania (✉)
School of Mathematics and Computer Applications, Thapar University, Patiala, Punjab, India
e-mail: ankush.pathania@gmail.com

A.K. Lal
e-mail: aklal@thapar.edu

T. Kumar
Vidya Sagar College of Management and Technology, Patiala, Punjab, India
e-mail: tarunsamana@gmail.com

1 Introduction

White dwarf stars are the final evolutionary stage of the vast majority of stars. More than 97 % of all stars, including our sun, are expected to become white dwarfs (Althaus et al. 2010). The study of white dwarf has potential application in different fields of astrophysics. This has led to renewed interest in calculation of very detailed evolutionary and pulsational models of these stars. Many white dwarf stars are observed to be the components of various close binary systems. This is a common situation in novae, dwarf novae and symbiotic stars. Observations show that in most of the binary systems the components are rotating about their axis and also revolving about center of the mass of the system. The structure and oscillations of such white dwarf stars that are the components of a binary system are being influenced by rotational and tidal distortions. In this paper and from hereafter we will use the terms rotationally distorted stars for those stars that are distorted by rotational effects only, tidally distorted stars refer to the stars that are distorted only by the tidal effects of companion (although such tidally distorted stars does not exists in observations but from theoretical point of view we have considered such cases also), and rotationally and tidally distorted stars refer to those stars that are distorted by the combined effects of rotation and tidal distortions.

The oscillations of the white dwarf models of the stars have been studied by various authors in literature. However, in the present work we have considered only those papers that are closely related to our problem under investigation. (The interested reader is referred to the review articles of Koester (2002), Hansen and Leibert (2003) and Althaus et al. (2010) for general overviews of the field, Winget and Kepler (2008) and Fontaine and Brassard (2008) for recent accounts of the observational aspects and applications of pulsating white dwarfs.)