

# Binary Stars 3D

## An app for teaching astronomy

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**Abstract.** In this work we will present an app that can be used for both teaching and research. This app simulates a compact binary stellar system and also the light curve of such a system. The app is operated in three different modes. With the app we hope to contribute with the insertion in the market of pedagogical tool that uses a smartphones and tablets technology increasingly present in the hands of researchers, students and teachers.

**Resumo.** Neste trabalho vamos apresentar um aplicativo que para ser utilizado como ferramenta didática, um aplicativo que simula de forma tridimensional um sistema estelar binário compacto e também a curva de luz deste sistema. O aplicativo é operado em três diferentes modos e foi desenvolvido para aparelhos que possuem o sistema operacional android. Com o aplicativo esperamos contribuir com a inserção no mercado de uma ferramenta didática que utiliza os smartphones e tablets, tecnologia cada dia mais presente nas mãos de pesquisadores, alunos e professores.

**Keywords.** Stars: mass-loss – binaries: general – Teaching of Astronomy

### 1. Introduction

A binary stellar system it is composed of two stars that are connected under attraction of mutual gravity and which orbit a center of mass common. Currently, we know that more than half of the stars in the sky, about 60% of the stars of the Milky Way are in systems like these or with more stars as described by osorio.

Such systems are great laboratories in which to study diverse physical contents as Law of Universal Gravity and at Laws of Kepler. However, systems like these are studied by direct observation, which depends on some variables such as climate, power of the telescope used, whether the system is eclipsed or not, among others. Images and animations for computers such as "StarLightPro", which are used for systems studies, but without much interaction with the user and the use of a resource anywhere in the classroom and easily in the hands of the students.

Taking into account the various variables that involve the study of systems like these and the fact that the number of users of mobile devices has been increasing exponentially and that the use of mobile technologies makes it possible for learning to occur at any time, by anyone as pointed out by Neves et al. (2014) and supported by the National Curriculum Parameters (PCN's) and its complementary guidelines (PCN +), specifically in the theme "Universe, Earth and Life", which presents the teaching of astronomy, we will present in this work an application that simulates three-dimensional and interactive form a compact binary stellar system designed for mobile devices, smartphones and tablets, which use Android technology.

### 2. App Description

Binary Stars 3D is an app developed in the programming language C sharp (C#) on the Unity 3D platform that simulates a compact binary stellar system composed of a white ana star and a low main sequence star, also called primary and secondary respectively. The app is operated in three different modes.

In mode 1 (Fig. 1) the two stars of the main sequence they fill the lobe of Roche (LR).

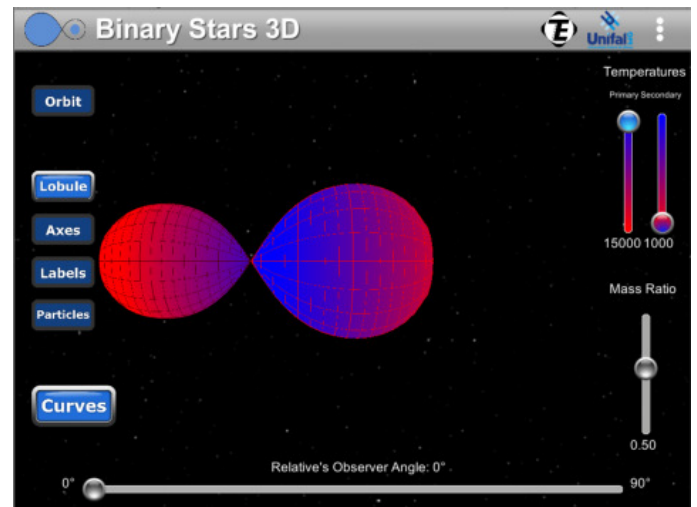


FIGURE 1. Semi-Contact Binary System.

In mode 2 (Fig. 2) the secondary star fills LR and the primary star is a white dwarf.

At last (Fig. 3), the secondary star expands beyond its LR, and we see the shape of the disk of accretion around the white dwarf. This accretion disk is formed due to the mass loss of the secondary star by the lagrangian point  $L_1$ .

In all three modes it is possible to place the system to orbit around the center of mass, visualize the spatial dimensions  $x, y, z$ , vary the angle of observation, the three collinear lagrangian points,  $L_1, L_2$  e  $L_3$ , vary the ratio of masses of the system,  $q = \frac{m_1}{m_2}$ , the temperature of the stars and simulate the light curve (Fig. 4) and send the data by e-mail.

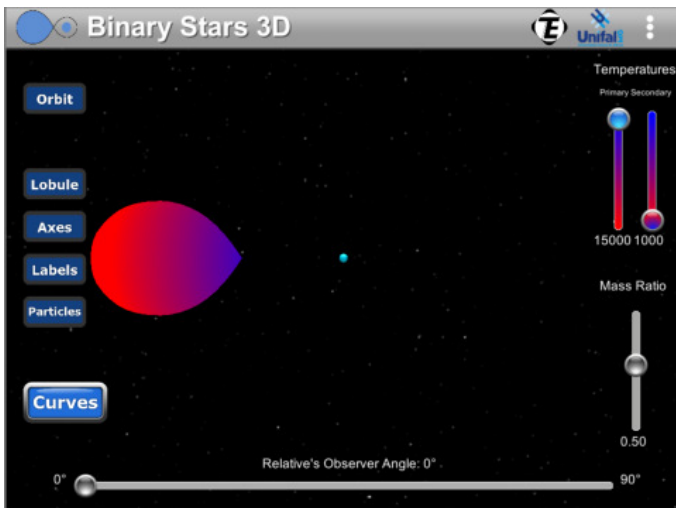


FIGURE 2. Roche lobes of the Binary System.

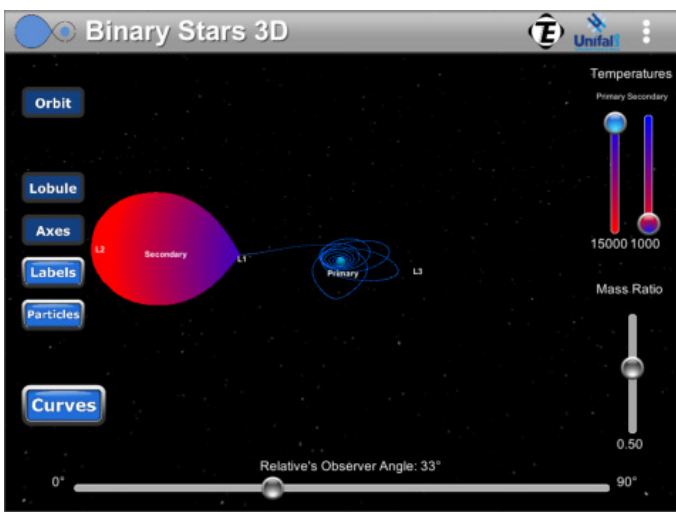


FIGURE 3. Formation of the Accretion Disc.

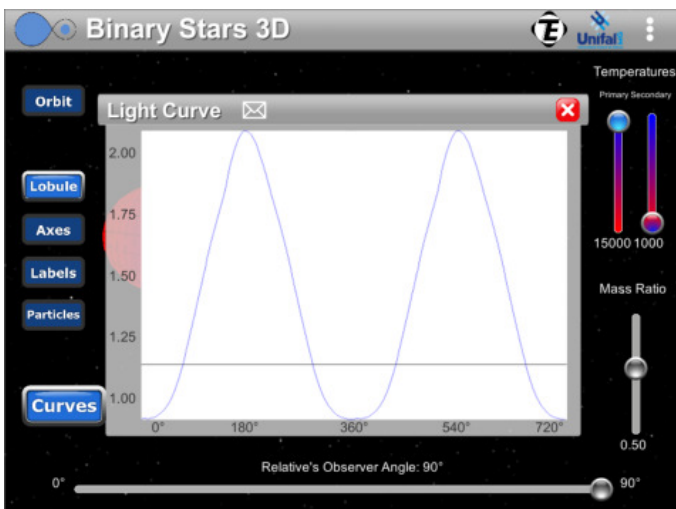


FIGURE 4. Binary System Light Curve.

### 3. Conclusion

The app showed great feedback regarding interactivity, performance, graphics and we expect contribute to the teaching of astronomy. With the introduction of contents related to stellar

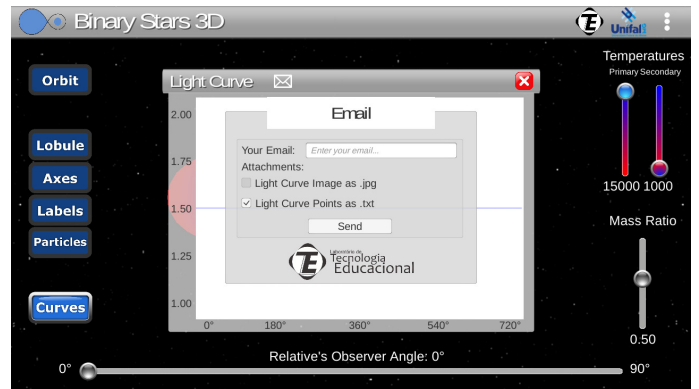


FIGURE 5. Data upload screen.

astrophysics in higher education and in the medium, using as teaching tool a technology that is widely used by students, smartphones and tablets.

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