

READMEgrorbits: FEATURES OF THE GRorbits PROGRAM

THE GRorbits PROGRAM

GRorbits is a general purpose interactive JAVA program that plots orbits of test particles and light flashes in the equatorial plane of a non-spinning (Schwarzschild) or a spinning (Kerr, with user-selected spin value) black hole. The software displays either the time-development of an orbit or the entire orbit over extended time. In the latter case the orbit changes instantly and continuously as the operator varies initial conditions. For the spinning Kerr black hole, the display shows the ergosphere (in which no particle can remain at rest) as well as the outer horizon and inner (Cauchy) horizon. The operator can use alternative global coordinate systems appropriate to the given black hole: Schwarzschild, Boyer-Lindquist, Gullstrand-Panlevé, and Doran. The interactive time-dependent display complements the static, analytic presentation of textbooks.

The GRorbits program is intended for use by anyone exploring general relativity. However, the program was developed specifically to coordinate with the proposed second edition of the text *Exploring Black Holes: Introduction to General Relativity* by Edwin F. Taylor, John Archibald Wheeler, and Edmund Bertschinger. (First edition 2000, Addison Wesley Publishers, ISBN 0-201-38423-X.)

The latest versions of GRorbits may be downloaded from the dropsite
<http://www.eftaylor.com/grsoftware/>

INSTRUCTIONS FOR OBTAINING JAVA RUNTIME ENVIRONMENT

The GRorbits program is a JAVA application, with a name that has the extension *.jar*. If double-clicking on the name or icon does not start the program, your computer is not JAVA enabled. You need to download and install the JAVA Runtime Environment from the website <http://java.com/en/>

Click DOWNLOAD NOW and follow the instructions that appear on the screen. This will install the JAVA version compatible with your particular operating system. You can now run JAVA applications and view Java applets—small computer programs embedded in web pages.

"BIG" AND "SMALL" GRorbits PROGRAMS

There are two GRorbits programs on this CD, with names ending in BIG and SMALL. The BIG program (currently about 750 KB) allows you to save the complete current initial parameters and settings. When you have set up the desired initial conditions, select the SAVE command in the FILE menu. You will be asked for a file name; the resulting file is stored in the same location as the GRorbits program with the extension *.xml*.

To call up a saved file select LOAD from the FILE menu and select the *.xml* file.

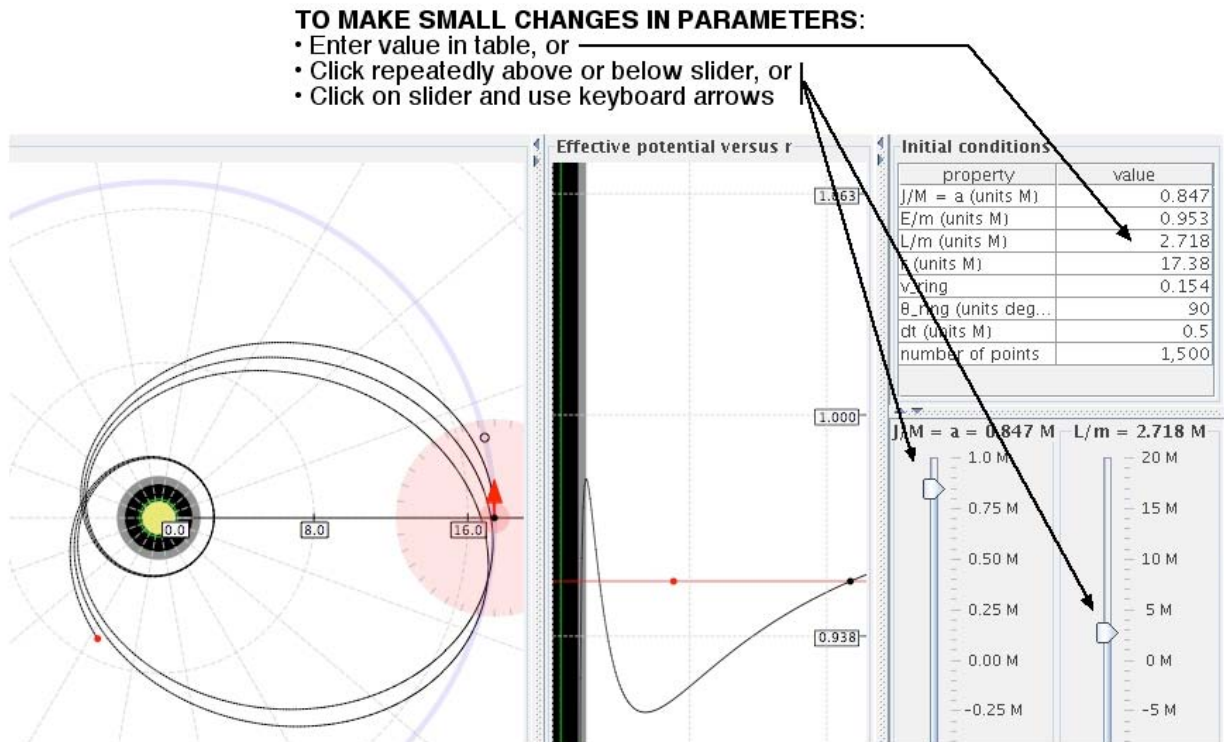
The saved *.xml* file is very small, so that it is easy to send between users of the GRorbits program. A compressed Scenarios folder contains a few sample sets of initial parameters of particular interest. Calling up the saved initial settings is most convenient if the *.xml* file is placed in the same folder as the GRorbits program.

The SMALL program is about 85 KB in size but does not allow you to save initial settings.

HINTS FOR USING GRorbits

Basic instructions for manipulating each of the three panels of the display appear at the bottom in red when the cursor is placed in that panel.

The diagram below shows how to make small changes in orbit parameters



DEFINITIONS OF TERMS

Definition of terms describing the black hole and orbit parameters can be found in the Index of *Exploring Black Holes* or in the Glossaries of Symbols and Terms near the end of that volume.

At the bottom left of the display are the numerical values of two times. The first time, called t , is either the bookkeeper time or the so-called rain time, depending on the selection by the operator under the Program Mode menu. The second time is tau (τ), the proper or wristwatch time of the orbiter. The proper time for an orbiting light flash is always zero. (Unfortunately, on some platforms the symbol tau looks like a capital T.)

HELP

You may obtain email help from either

Slavo Tuleja: stuleja@gmail.com

or

Edwin Taylor: eftaylor@mit.edu

There is no such thing as a free lunch; you will be asked for your reactions to the program and for suggestions to improve it.