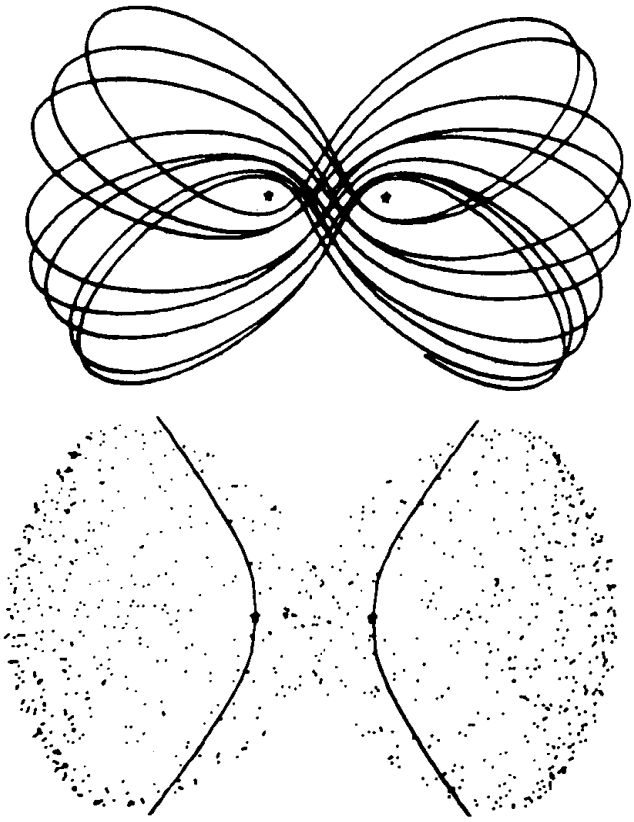
Physics2000



Student project by Bob Piela explaining the hydrogen molecule ion.

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Preface

ABOUT THE COURSE

Physics2000 is a calculus based, college level introductory physics course that is designed to include twentieth century physics throughout. This is made possible by introducing Einstein's special theory of relativity in the first chapter. This way, students start off with a modern picture of how space and time behave, and are prepared to approach topics such as mass and energy from a modern point of view.

The course, which was developed during 30 plus years working with premedical students at Dartmouth College, makes very gentle assumptions about the student's mathematical background. All the calculus needed for studying Physics2000 is contained in a supplementary chapter which is the first chapter of a ***Physics Based Calculus*** text. We can cover all the necessary calculus in one reasonable length chapter because the concepts are introduced in the physics text and the calculus chapter only needs to handle the formalism. (The remaining chapters of the calculus text introduce the mathematical tools and concepts used in advanced introductory courses for physics and engineering majors. These chapters will be available at ***www.physics2000.com*** in late 2000.)

In the physics text, the concepts of velocity and acceleration are introduced through the use of strobe photographs in Chapter 3. How these definitions can be used to predict motion is discussed in Chapter 4 on calculus and Chapter 5 on the use of the computer.

Students themselves have made major contributions to the organization and content of the text. Student's enthusiasm for the use of Fourier analysis to study musical instruments led to the development of the MacScope™ program. The program makes it easy to use Fourier analysis to study such topics as the normal modes of a coupled aircart system and how the energy-time form of the uncertainty principle arises from the particle-wave nature of matter.

Most students experience difficulty when they first encounter abstract concepts like vector fields and Gauss' law. To provide a familiar model for a vector field, we begin the section on electricity and magnetism with a chapter on fluid dynamics. It is easy to visualize the velocity field of a fluid, and Gauss' law is simply the statement that the fluid is incompressible. We then show that the electric field has mathematical properties similar to those of the velocity field.

The format of the standard calculus based introductory physics text is to put a chapter on special relativity following Maxwell's equations, and then put modern physics after that, usually in an extended edition. This format suggests that the mathematics required to understand special relativity may be even more difficult than the integral-differential equations encountered in Maxwell's theory. Such fears are enhanced by the strangeness of the concepts in special relativity, and are driven home by the fact that relativity appears at the end of the course where there is no time to comprehend it. This format is a disaster.

Special relativity does involve strange ideas, but the mathematics required is only the Pythagorean theorem. By placing relativity at the beginning of the course you let the students know that the mathematics is not difficult, and that there will be plenty of time to become familiar with the strange ideas. By the time students have gone through Maxwell's equations in ***Physics2000***, they are thoroughly familiar with special relativity, and are well prepared to study the particle-wave nature of matter and the foundations of quantum mechanics. This material is not in an extended edition because there is time to cover it in a comfortably paced course.

ABOUT THE *PHYSICS2000* CD

The ***Physics2000*** **CD** contains the complete color version of the ***Physics2000*** text in Acrobat™ form along with a supplementary chapter covering all the calculus needed for the text. Included on the CD is the 36 minute motion picture *Time Dilation - An Experiment With Mu-Mesons,* and short movie segments of various physics demonstrations. Also a short cookbook on several basic dishes of Caribbean cooking.

The CD is available, for $10 postpaid, at the web site

www.physics2000.com

The black and white printed copy of the text, with the calculus chapter, is also available at the web site at a cost of $25. That includes the CD and shipping within the United States.

Use of the Text Material

Because we are trying to change the way physics is taught, Chapter 1 on special relativity, although copyrighted, may be used freely (except for the copyrighted photograph of Andromeda and frame of the muon film). All chapters may be printed and distributed to a class on a non profit basis.

ABOUT THE AUTHOR

E. R. Huggins has taught physics at Dartmouth College since 1961. He was an undergraduate at MIT and got his Ph.D. at Caltech. His Ph.D. thesis under Richard Feynman was on aspects of the quantum theory of gravity and the non uniqueness of energy momentum tensors. Since then most of his research has been on superfluid dynamics and the development of new teaching tools like the student-built electron gun and MacScope™. He wrote the non calculus introductory physics text ***Physics1*** in 1968 and the computer based text ***Graphical Mechanics*** in 1973. The ***Physics2000*** text, which summarizes over thirty years of experimenting with ways to teach physics, was written and class tested over the period from 1990 to 1998. All the work of producing the text was done by the author, and his wife, Anne Huggins. The text layout and design was by the author's daughter Cleo Huggins who designed eWorld™ for Apple Computer and the Sonata™ music font for Adobe Systems.

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The author welcomes any comments.

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