Using Web technology in undergraduate research

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USING WEB TECHNOLOGY IN UNDERGRADUATE RESEARCH

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In many universities and colleges, science and engineering majors are increasingly participating in undergraduate research projects. These activities stimulate the intellects of the students, encourage their creativity, and help them to develop new skills.

However, students often complain that research articles written in professional journals are too technical for them to read. The students have difficulty in understanding even the main idea of a paper, let alone the derivations involved in the calculations. This difficulty might discourage some students from pursuing graduate studies. It certainly does not stimulate their involvement in undergraduate research projects.

On the other hand, Web technology is beginning to play a significant role in higher education. Faculty members are putting their teaching materials online (CIP 12:3, 1998, p. 227), and new paradigms for Web-based instruction are under development (CIP 12:4, 1998, p. 322). In addition, electronic research journals are becoming more common (CIP 10:3, 1996, p. 216).

In this article, we describe how to use Web technology to enhance the educational content of research papers. Web versions of research papers can incorporate features specifically intended for students. In the Web ver-

Box 1. HTML for Equations 1 and 2

```
<table border="0" width="100%" noborder>
    <tr>
        <td><p align="center"><font face="palatino">(</font><font face="symbol">r
        </font><font face="palatino">U</font><font face="symbol"><sub>a</sub></font>
        <font size="3" face="palatino">U</font><font size="3"
        face="symbol"><sub>b</sub> </font><font size="3" face="palatino">+ P </font>
        <font size="3" face="symbol">d <sub>a b</sub> </font><font size="3"
        face="palatino">)<sub>, </sub></font><font size="3"
        face="symbol">b</font></sub><font size="3" face="times"> = </font>
        <font size="3" face="symbol">r</font><font size="3"
        face="times"> V</font><font size="3"
        face="symbol"><sub>a</sub></font><font size="3" face="palatino"> , </font>
    </td>
    <td width="1%"><font size="3" face="palatino">(1) </font>
    </td>
</tr>
<tr>
    <td><p align="center"><font size="3" face="palatino">(</font><font size="3"
        face="symbol">r</font><font size="3" face="palatino"></font><font size="3"
        face="palatino size=3">U</font><font size="3" face="symbol"><sub>a</sub>
        </font><font size="3" face="palatino">)<sub>,</sub></font><font size="3"
        face="symbol">a</font></sub><font size="3" face="palatino"> = 0, </font></td>
    <td width="1%"><font size="3" face="palatino">(2) </font></td>
</tr>
</table>
```

$$(\rho \, U_\alpha U_\beta + P \, \delta_{\alpha\beta})_{,\beta} = \rho \, V_\alpha \,, \qquad (1)$$

$$(\rho \, U_\alpha)_{,\alpha} = 0 \,, \qquad (2)$$

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AN ALTERNATIVE PROCEDURE TO STUDY ELLIPTICAL GALAXIES SHAPE IN NEWTONIAN AND NON-NEWTONIAN GRAVITATIONAL THEORIES

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ABSTRACT

By using a straightforward procedure we were able to solve in closed form the hydrodynamical Euler equations inside homogeneous self-gravitating ellipsoids.

As a consequence, we easily proved that oblate elliptical galaxies can exist in the framework of Newtonian and Weyl gravitational theories (Weyl gravity is a non-Newtonian gravitational theory that includes in the gravitational potential a linear term in addition to the standard $1/r$).

As a further application, planets in our solar system are modeled by Maclaurin spheroids to estimate its eccentricities. A good agrement with available planetary data is found for the "rocky planets," i.e., Mercury, Mars, Earth, and Venus.
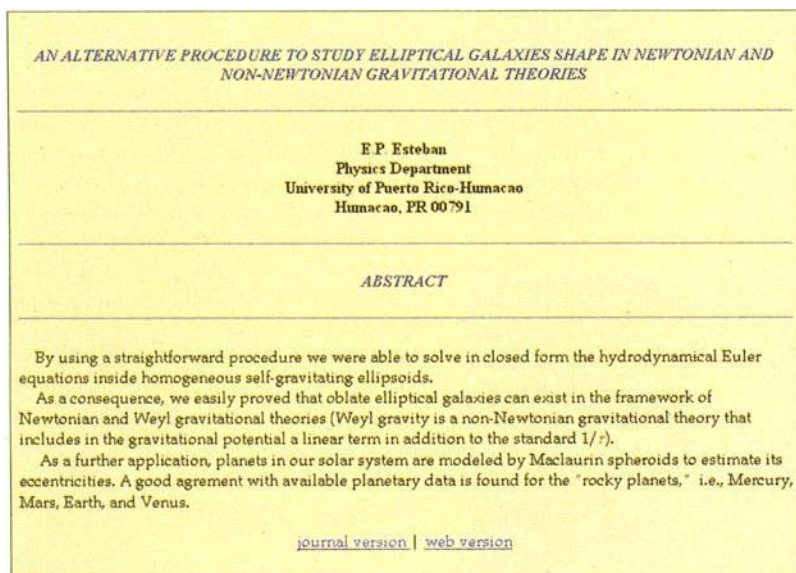
journal version | web version

Figure 1. The online abstract of the research paper. Links to the standard journal version (plain text) and to the paper's Web version are provided for the readers' convenience.

I. INTRODUCTION

As is well known, galaxies have different shapes. Several proposed schemes for a morphological classification of galaxies can be found in the literature. But, is it possible for physical laws to explain the shapes of galaxies?

Recently, Florides and Spyrou[1] proved that homogeneous prolate elliptical galaxies are forbidden in a Newtonian-physics (NP) framework. However, these types of galaxies have been observed and reported by astronomers.[2] On the other hand...
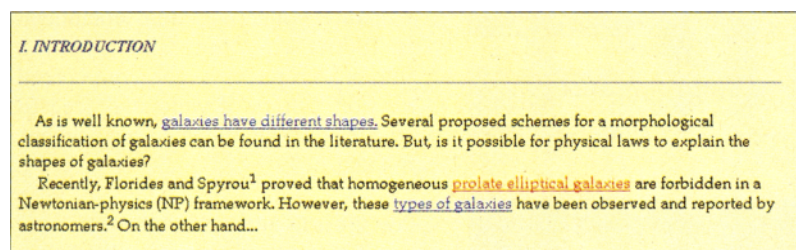
Figure 2. By following "soft" links in blue to chosen Web sites, students can find explanations of topics with which they might be unfamiliar. "Hard" links in red provide students with technical details or the derivations of equations.

sion, a research topic can be explained in a more pedagogically appropriate, relaxed, and animated way than is possible in print. A Web paper can reach a large audience of readers, from whom authors can obtain quick feedback. Web versions of research papers not only stimulate the involvement of undergraduate students in research activities, but also immerse them in a powerful learning environment.

As an added benefit, Web versions of research papers can be updated and modified by researchers whenever necessary. Researchers and students normally give seminars and talks based on research projects. Most of these presentations are given in PowerPoint or similar programs. Since converting from PowerPoint to HTML is easily accomplished, students who were not able to attend a seminar can still profit by studying the slides that were presented if the authors add these slides to the Web version of their paper. In contrast, the printed version of a paper is forever frozen.

The main disadvantage in designing Web versions of research papers is that this process may take a long time. However, this time investment will be recovered in the end, because researchers will ultimately need to spend less time explaining basic concepts and derivations to students. Creating a Web version of a paper allows undergraduate students to acquire an in-depth knowledge of a research project.

Web versions of research papers can also benefit people outside academia, as well as scientists involved in other fields of research. Web papers can include what we call "soft links" to chosen Web sites. These sites provide explanations and tutorials on topics mentioned in the paper but unfamiliar to readers who are not experts. In this way, nonexperts can arrive at a basic understanding of a research project. Publishing papers online with general readers in mind has the potential to open a much-needed channel of communication between the scientific community and members of the society at large.

As an example of our proposal, we have developed a Web version of an actual research paper, which can be found in http://cuhwww.upr.clu.edu/~eesteban/web_paper98. Of course, we do not claim that our Web format has to be followed. However, it satisfies what we think are the minimal requirements for creating Web versions of research papers that are accessible to students.

The paper's online abstract provides readers with two options: read the paper "journal style" (plain text online) or go to the "Web version" (see Fig. 1). In the Web version, soft and hard links in blue and red respectively are provided throughout the paper (see Fig. 2). A hard link allows students to jump to a Web page supplied by the researcher so as to explain technical details or present fuller derivations of the equations that appear in the paper.

A physics research paper normally contains text, equations, and graphics. Converting the text into HTML can be performed automatically using Claris Home Page 3.0 or Microsoft Word 97. In addition, Word 97 can also convert equations and graphics into GIF files for posting on the Web. However, some bugs have been reported with the numbering of equations in this program.[1] Another method of posting equations on the Web is to use a screen-capture program to make a GIF file.[2] Still other approaches to putting mathematical material online can be found at http://www.text2html.com/compete/ and http://hutchinson.belmont.ma.us/tth/Webmath.html.

For the Web version of our research paper, we have used HTML and Claris Home Page 3.0 to write the equations. Box 1 presents a template in which Eqs. 1 and 2 have been rendered in HTML. It is easier to write equations using

Creating a Web version of a paper allows undergraduate students to acquire an in-depth knowledge of a research project.

Claris Home Page 3.0, however, than it is to code them directly using HTML.

Figure 3 displays two screens that graphically illustrate a three-step procedure to write the same equations using Claris Home Page 3.0. First open a new page in Claris Home Page and insert a table with the "Insert" and "Table" options. Then choose the number of rows and columns (Fig. 3a), as well as the cell's size (Fig 3b). Finally, pull down the "Style" menu in order to write the equations into the new cell (Fig. 3c), alternately using the Symbol and Palatino fonts.

Other mathematical symbols can also be easily written using this software. First choose the "HTML" code in the "Insert" menu to get the screen shown in Fig. 4. Then write the appropriate HTML code for the desired math symbol. A list of sample HTML codes also appears in Fig. 4. Greek letters can be produced by following an analogous procedure.

The Mathematical Markup Language, MathML, was recently released. MathML is designed to enable mathematical symbols to be served, received, and processed on the Web. Details can be found at http://www. w3.org/TR/PR-math.

For researchers using TeX or La-TeX, several HTML conversion programs are on the market. We have tested T_tH with good results. This software converts a TeX document, including equations and graphics, into a Web page. A non-commercial version can be downloaded free of charge from http://hutchinson.belmont. ma.us/tth/.

Navigation and screen design

For the Web version of the paper, we have chosen a navigation scheme implemented with FrontPage98 based on two-column frames. This format has proven effective for posting books in the Web.[3] FrontPage 98 is better suited to the task of creating frames than Claris Home Page 3.0. Step-by-step instructions on how to create frames with FrontPage 98 can be found at http://cuhwww.upr.clu. edu/~eesteban/creating_frames.

Figure 5 shows a typical page layout for our Web paper. The left column holds JavaScript buttons that correspond to the standard sections of a research paper. Note that in the left column a "Referee" button was added to provide interactivity between the researcher and the readers.

By clicking these buttons, users can easily jump from section to section in the paper. The right column displays the contents of each section. The JavaScript buttons in the left-hand column are always on display, even if the user scrolls the contents of the right frame.

The left-hand navigation frame

$$(\rho\, U_\alpha U_\beta + P\, \delta_{\alpha\beta}),_\beta = \rho\, V_\alpha, \qquad (1)$$
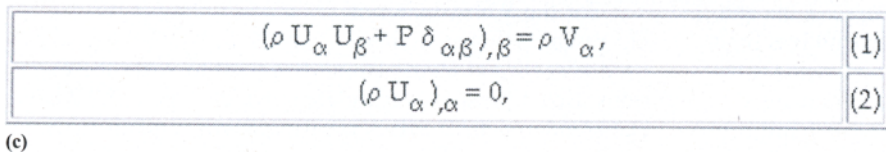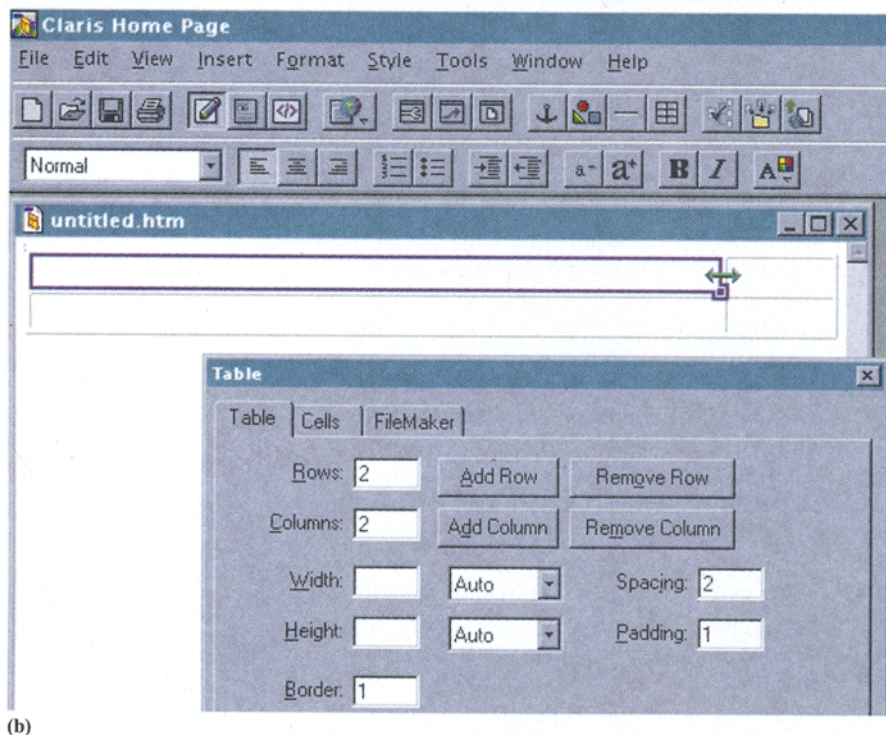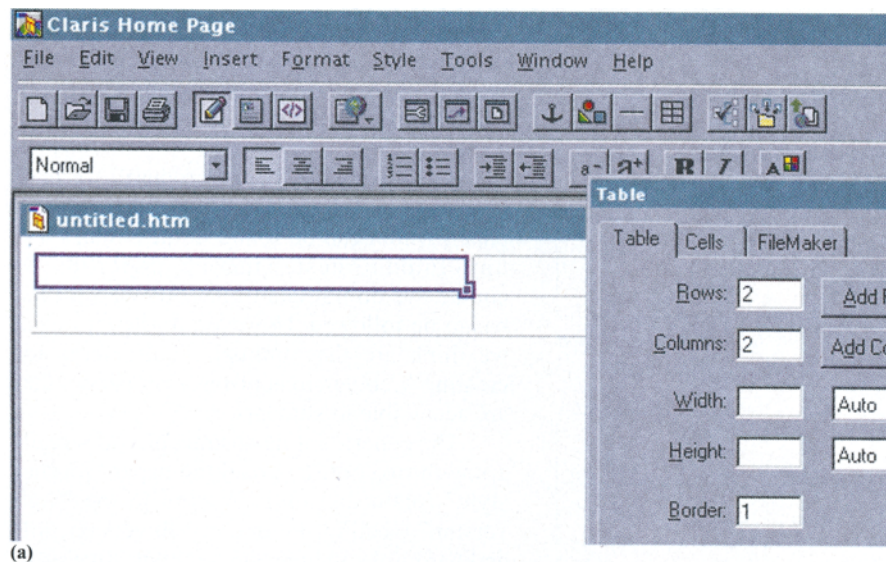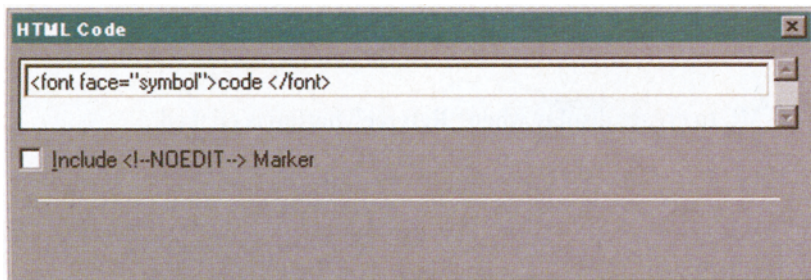
$$(\rho\, U_\alpha),_\alpha = 0, \qquad (2)$$

Figure 3. Claris Home Page 3.0 allows authors to write equations for the Web more easily than they can using HTML. For a discussion of parts a, b, and c, see text.

HTML Code

```
<font face="symbol">code </font>
```

☐ Include <!--NOEDIT--> Marker

Math Symbols	HTML code	Math Symbols	HTML code
∫	ò	≤	£
√	Ö	≥	³
∂	¶	≠	¹
∞	¥	≡	º
±	±	≈	»
→	®		

Figure 4. Sample HTML codes by Claris Home Page 3.0 produce various mathematical symbols.

Box 2. JavaScript code for buttons in Fig. 5.

```
<html>
<head>
   <base target="main">
<title></title>
</head>
<script>
   function jump(x)
      {
         window.open(x,"main");
      }
</script>
<body BGCOLOR="#FFFFbb">
<form name="f1" style="font-family: palatino">
<div align="left"><table border="0" width="30">
<tr>
   <td width="125" align="center"><div align="center"><center><p><font face="palatino">
   <input type="button" name="one" value="ABSTRACT"
   onclick="jump(&quot;abs.htm&quot;)" style="font-family: palatino; font-size:
   10"></font><br>
      </td>
</tr>
<tr align="center">
   <td width="125" align="center"><div align="center"><center><p><font face="palatino">
   <input type="button" name="five" value="ECCENT..."
   onclick="jump(&quot;planetas.htm&quot;)" style="font-family: palatino;
   font-size: 10"></font><br><br>
      </td>
</tr>
</table>
</div>
</form>
</body>
</html>
```

can also contain simple HTML hyperlinks. There is no noticeable difference, however, in downloading time between the JavaScript and standard hyperlink approaches.[3] Moreover, JavaScript offers the opportunity to create truly interactive Web pages and may play a role in further enhancing a paper's Web version.

In Box 2, we show the scripts for the buttons "Abstract" and "Eccentricities" that appear in Fig. 5. The remaining buttons are created with similar scripts. Box 3 is the coding for the Web page that appears when the "Referee" button is clicked.

Since most research papers have comparable sections and structure, these templates can be easily adapted by researchers to develop Web versions of their own research papers.

Student involvement

Making the transition from the print version to the Web version of the paper involves several intermediate steps. To minimize the time required to develop the Web version, we suggest the following rule of thumb. Research papers with few equations or none should be written with Claris Home Page 3.0. Research papers with many equations should be written with TeX or LaTeX and automatically converted into Web pages with text, equations, and graphics, using T_tH or another translator.

Researchers should involve students in the design and development of the Web version of a research paper. The researcher writes the first draft of the paper's Web version and includes the hard links. Meanwhile, students surf the Web looking for soft links and contribute ideas toward enhancing the Web design.

In our department we have tested the effectiveness of Web versions of research papers in meeting our goals. Five students working under our supervision as research assistants were encouraged to use a paper's Web version to become acquainted with an astrophysics research project. The students all liked this approach and offered positive feedback. Two of the students were involved in enhancing the Web paper's design.

Only time will reveal the

impact that Web versions of research papers will have on undergraduate students. A large number of researchers will first have to develop pedagogical Web materials describing their work. However, we strongly believe that the synergy between Web technology and higher education will change traditional ways of introducing undergraduate students to research projects. Web technology and HTML are constantly improving. The design, development, and implementation of Web versions of research papers will also become easier in time.

A final comment: Given that universities in Third World countries and small colleges cannot afford to subscribe to a large number of professional journals, scientists working in these environments have a difficult time keeping up-to-date in their disciplines. Even if they can obtain a research article of interest, following up on its references is not an easy task. The wide availability of Web versions of research papers can help in both respects. A paper's references can be easily scanned and added to the Web version, if permission is granted by the copyright holder. Likewise, the increasing availability of Web versions of research papers will make it feasible for researchers to follow up on references online.

Acknowledgments

Box 3. HTML to create display when "Referee" button is clicked.

```html
<html>
<head>

  <meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
  <meta name="GENERATOR" content="Microsoft FrontPage 3.0">

<title></title>
</head>

<body bgcolor="#FFFFbb">

  <align=left>

  <form action="mailto:E_Esteban@cuhac.upr.clu.edu" method="POST"
  enctype="text/plain">

    <p><font color="#FF0000" size="5">REFEREE
    COMMENTS</font><br>
    Here you can become a referee for the Web version of the paper.
    Make any comments (be gentle) on the physical content as well
    as the Web design of the paper.<br>
    Type your comments into the box and click the send button
    below. This method will be in a near future completely anonymous,
    so if you want us to respond to you directly, please include
    your name,e-mail, or some way for us to get in touch.<br>
    <br>
    <textarea name="COMMENTS" rows="6"
    cols="50"></textarea><br>
    <br>
    <input type="submit" value="SEND COMMENT"> <br>
    <br>
    </p>

  </form>
  <p align="right"> </p>
</body>
</html>
```

II. PLANETARY ECCENTRICITIES IN OUR SOLAR SYSTEM

ABSTRACT · INTROD... · PROCED... · ECCENT... · CONCLU... · REFEREN... · ACKNOL... · BE A REF...

What is Earth's eccentricity? Nowadays, the answer is known, but until the 1700s, Earth's shape was assumed to be a prolate spheroid. A great defender of this theory was an astronomer named Cassini. Newton, however, using what he called the methods of canals, predicted that Earth's shape should be an oblate spheroid. A controversy about Earth's shape was immediately raised between Cassini's and Newton's competing results. An interesting drawing from that time can be found in Ref. 4.

This controversy was finally settled by Maupertuis and Clairut in an expedition to Lapland (Sweden). By doing geodetic measurements they proved that Newton was indeed correct. Thus, Earth's shape is an oblate spheroid.

However, as pointed out in Ref. 4, Newton's method is only valid for very small values of the eccentricity $z = (1 - c^2/a^2)^{1/2}$ where in this case c and a are the polar and equatorial radii, respectively. Some years later, Maclaurin generalized Newton's results by obtaining a...
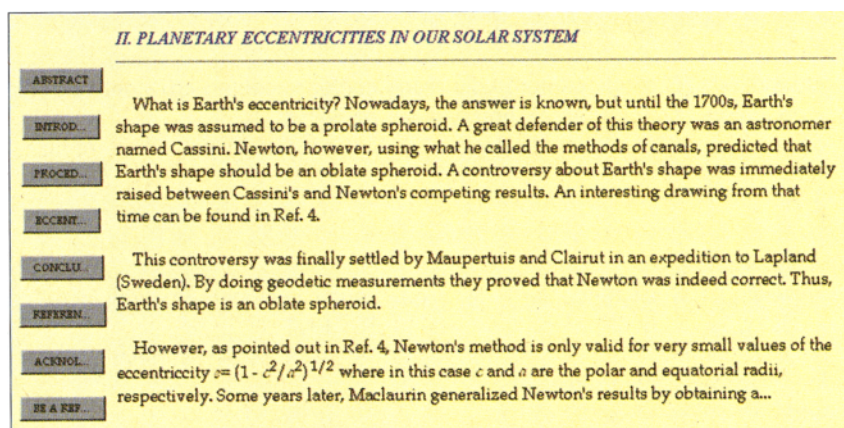
Figure 5. Web version is laid out in two-column frames, with JavaScript buttons in the left-hand column for navigation through the major divisions of the paper.

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