ONLINE TOOLS FOR ASTRONOMY AND COSMOCHEMISTRY. B. S. Meyer, Department of Physics and Astronomy, Clemson University, Clemson, SC 29634-0978 (mbradle@clemson.edu).

Introduction: Over the past year, the Webnucleo Group at Clemson University has been developing a web site with a number of interactive online tools for astronomy and cosmochemistry applications. The site uses SHP (Simplified Hypertext Preprocessor), which, because of its flexibility, allows us to embed almost any computer language into our web pages. For a description of SHP, please see

http://www.joeldenny.com/

At our web site, an internet user may mine large and complex data sets, such as our stellar evolution models, and make graphs or tables of the results. The user may also run some of our detailed nuclear physics and astrophysics codes, such as our nuclear statistical equilibrium code, which is written in fortran and C. Again, the user may make graphs and tables and download the results. The web site is located at

http://nucleo.ces.clemson.edu/

The online tools all run on a SunFire V480 computer generously donoted to our group by SUN Microsystems under an Academic Excellence Grant. This computer is professionally maintained by the College of Engineering and Science at Clemson University.

In the remainder of this abstract, I will describe a number of the online tools (which we term modules because they are able to interact with each other) that may be of interest to the cosmochemistry community, to students, and to the general public. All of these modules have links from the home page above.

Galactic Chemical Evolution Module: We have already presented the Clemson University Galactic Chemical Evolution Module [1], but it demonstrates a number of capabilities of some of our online tools. With this module, an internet user may run models of the chemical evolution of the Galaxy using input yields from the stellar evolution models of Woosley and Weaver [2]. The user may then choose an Initial Mass Function, a mass infall timescale, a star formation rate, and a remnant mass function. Once these parameters are choosen and entered, the chemical evolution is calculated on the webserver at Clemson. Upon completion of the calculation, the module allows the internet user to make graphs or tables of the results and download them to the local computer. The underlying graphics package for making the online graphs is IDL (Interactive Data Language) from Research Systems Inc. This module may be particularly useful for researchers seeking to understand chemical evolution effects in presolar meteoritic grains.

Solar Abundances Module: The Solar Abundances Module allows an internet user to upload, sort, and display solar abundances. In using this module, the user begins by uploading an XML file of the solar abundances. XML (eXtensible Markup Language) is the W3C standard for information sharing on the internet. W3C is the World Wide Web Consortium that develops tools and sets standards for the interoperable web. For more about their activities, please see

http://www.w3c.org/

In XML, data are presented as text inside of opening and closing markup tags. We provide a default XML file of the solar abundances provided by Anders and Grevesse [3]. The user may simply use this file or download it , modify it, and upload the modified file back onto our webserver. Our upload script automatically checks the uploaded file for correct form by validating against an XML Schema we have written. (XML Schemas are a W3C standard.) If the uploaded file has an error, the validator informs the user about the line and column number at which the error occurs in the file.

Once a valid XML file is uploaded onto the webserver, we use XSLT (eXtensible Stylesheet Language Transformations—a W3C standard) to sort and display the solar abundances. The user may then download results to the local computer.

Nuclear Data Module: The Nuclear Data Module allows an internet user to explore masses and binding energies, spins, and nuclear partition function data of nuclei. As with the solar abundances module, the raw data are stored in an XML file. Where available, the file contains experimental nuclear masses from the compilation of Audi, Wapstra, and Thibault [4,5]. Where only theoretical masses are available, we employ the Finite Range Droplet Model extrapolations of P. Moeller and collaborators [6]. Nuclear partition functions are those calculated by T. Rauscher [7].

The user may choose these data or may download the XML file, modify it, and reupload it to the webserver. Again, the upload script validates the file against an XML Schema. The internet user may then display data via SHP, XSLT, and IDL. We point out that, once a valid nuclear data XML file is available on the server, it may be used for other applications, such

as the Nuclear Statistical Equilibrium Calculator (see below).

Nuclear Statistical Equilibrium Calculator: Certain refractory inclusions show isotopic anomalies in the neutron-rich isotopes of the iron-group nuclei (e.g., [8]). These isotopes were long-considered to be products of neutron-rich NSE (nuclear statistical equilibrium) [9], and cosmochemists have compared the results of neutron-rich NSE calculations to the inclusions. We now understand that these isotopes are more likely the products of low-entropy quasi-statistical equilibria (QSE)[10], nevertheless, astronomers and cosmochemists may find it useful to be able to compute NSEs simply to gain insight into the relevant processes. The Nuclear Statistical Equilibrium Calculator allows an internet user to make his or her own NSE calculation and to produce graphs and tables of the results. NSE calculations require nuclear data; thus, the NSE Calculator first calls the Nuclear Data Module to obtain a valid nuclear data XML file. Once that is available, the user inputs the requisite temperature, density, and electron fraction range. Upon input, the NSE Calculator runs the Clemson NSE code (written in Fortran and C) and returns the results in a large data file. The internet user may then access that file, make graphs and tables of the results, and even download the data file for subsequent upload and analysis.

If the NSE Calculator determines that the calculation will take more than several minutes to run, it will place the calculation in the background. The user may then close his or her browser. When the calculation is completed, the NSE Calculator will send the user an email indicating that the calculation is done and describing how to access the results.

Nuclear Reaction Module: The Nuclear Reaction Module allows an internet user to view nuclear reaction rates used in nuclear reaction network calculations. Again the user may choose the default XML file (with reaction rates from [11-13]), or download that file, modify it, and upload it to the webserver. The module then uses SHP, XSLT, and IDL to allow the user to view any of the reaction data in the input file. These data are used in the Radioactive Decay Module described below and the Nuclear Network Module we are currently preparing.

Radioactive Decay Module: The radioactive decay module allows an internet user to input an initial set of abundances and then to follow their radioactive decay for an input interval of time. The module first calls the Nuclear Reaction Module to allow the user to input his or her own decay rates, if desired. It then calls a Fortran and C code that computes the radioactive decay of the input species. Again, SHP, XSLT, and IDL allow the user to display and download the results. This module may be particularly interesting to those seeking to compute the abundances from supernova models some time after the supernova explosion.

Community-Supplied Modules: We have a number of other modules relevant to astronomy and cosmochemistry in the planning or preparation stage, so we are updating the site with some frequency. Anyone interested in our modules may wish to visit out site periodically. We certainly welcome suggestions as to how to improve our modules.

We also welcome suggestions about what other modules would be useful for us to develop. As we improve our programming capabilities and infrastructure, we expect to become increasingly able to accomodate most such suggestions.

Furthermore, if members of the community have codes they would like to make into modules on our site, they should contact the author. Because of SHP's flexibility, we are able to put robust code written in almost any language onto the web. We have found that this is an excellent way of making such codes more available and of preserving them for the future.

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