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# The Energy Flux Modeling of Stellar Photospheres

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## Overview

We present the stellar energy flux modeling tool SYNTSPEC operating within Virtual Observatory infrastructure. The SYNTSPEC calculates the energy flux and the normalized to the continuum stellar spectrum which is applied for the stellar classification and determinations of e.g. chemical compositions, effective temperatures and surface gravities of stars. This enables astronomers to analyze observational data of GAIA and other modern observatories. The SYNTSPEC is a gridified package for analysis of stellar spectra. It is an example of data- and compute-intensive application running on the testbed of the European GRID Infrastructure (EGI), which brings a new quality to the research in astrophysics. The multi-job application is based on the Gridcom system –a user friendly interface that allows a common (virtual) work of the physically spread scientific group and the Virtual Observatory type of storage and standards.

## Impact

The SYNTSPEC application benefits from the usage of large resources enabling the calculation of synthetic stellar spectra for the 200 –1500 nm wavelength range which is essential for the galactic and stellar research studies. Running of the application within the Gridcom interface and using Virtual Observatory standards for visualization and accessibility, improved the job submission, analysis and visualization procedures and possibilities of the user interaction. The application can be submitted and analyzed by a spread group, that is especially important in the remote teaching or analysis of data. The SYNTSPEC will increase accessibility of the synthetic spectra in the Virtual Observatory, all data will be open for purposes of various scientific needs. The special objective for this software is the analysis of data of the GAIA space observatory (to be launched in 2011). The SYNTSPEC can reproduce the synthetic GAIA-like spectra for actual data analysis. The special SYNTSPEC SSAP database server will be installed to serve that kind of spectra for scientific community.

## Description of the work

The stellar interior is a dense and hot plasma environment where the energy is produced by fusion processes. It irradiates a specific flux of energy which spreads within a wide range of electromagnetic wavelengths. The photosphere is a part of star which modifies the energy flux distribution over all wavelength range. The atomic and molecular structure of photosphere redistributes the initial energy flux through all the spectrum employing absorption, reemission, scattering processes and forms a unique shape of the energy flux image of the specific star. The SYNTSPEC is closely connected to the Virtual Observatory structure. The International Virtual Observatory Alliance (IVOA) has developed the large infrastructure for the astronomical data management, visualization, analysis and reduction. Various surveys from space and ground observatories, theoretical data surveys are bounded by the Virtual Observatory structure. The SYNTSPEC application collects output data on a server dedicated for the Virtual Observatory system. The server runs using the Simple Spectral Access protocol Version 1.04 (SSAP), developed by the IVOA. The SSAP defines a uniform interface to remotely

discover and access 1-D spectra. The SSAP is based on a more general data model capable of describing most tabular spectrophotometric data, including spectral energy distributions as well as 1-D spectra. Clients first query the global resource registry to find services of interest. Clients then issue a data discovery query to selected services to determine what relevant data are available from each service. The candidate datasets available are described uniformly in a VOTable format document which is returned in response to the query. The access of 1-D spectra produced by the SYNTSPEC is possible by the SSAP from all Virtual Observatory tools which can work with 1-D spectra, e.g. the VOSpec (ESA) applet, the SPLAT-VO tool (Starlink), or simply, using the Virtual Observatory Query Language (VOQL).

## Conclusions

The energy flux from stellar photospheres and the normalized to the continuum spectra modeling in GRID environment is a powerful software for astronomers. It becomes a fine example of a user friendly tool with a significant scientific potential. Keeping in mind the approaching start of the GAIA mission, the future development of the application is planed although the main tasks are already achieved. It is important to make it more autonomous and time saving for scientists, so the collaboration with the International Virtual Observatory Alliance is a good way to reach our common goals.

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