Stellar energy flux modeling under SYNTSPEC application

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Abstract:

We present a gridified stellar energy flux modeling tool SYNTSPEC for stellar spectra analysis. It is an example of data- and compute-intensive application running on the testbed of the EGEE GRID compatible infrastructure, which brings the new quality to the research in astrophysics. The multi job application is running within the Gridcom system – the user friendly interface that allows a common (virtual) work of a physically spread scientific group. Atomic and molecular structure of stellar photosphere redistributes the initial energy flux through the entire spectrum employing absorption, reemission, scattering processes and paints a unique shape of flux image of the specific star. SYNTSPEC software calculates the energy flux and normalized to the continuum stellar spectra that are applied for stellar classifications and determinations of e.g. chemical compositions, effective temperatures and surface gravities of stars. The SYNTSPEC application benefits from the usage of large computing resources, which makes possible the calculation of synthetic stellar spectra for significant wavelength ranges and numbers of stellar parameter combinations. The specific energy flux modeling is an important tool for analysis of data, which will be produced by the European Space Agency's GAIA space observatory.

Analysis:

The stellar energy flux modeling is very important for stellar analyses. The stellar interior is a dense and hot plasma environment where energy is produced by fusion processes. It radiates a specific flux of energy, that is spread within all range of electromagnetic waves. The photosphere is the part of a star which modifies the energy flux distribution over the wavelength range. The atomic and molecular structure of photosphere redistributes the initial energy flux through all the spectrum employing absorption, reemission, scattering processes and paints the unique shape of flux image of a specific star. The energy flux calculation under SYNTSPEC is a very good example of applications that benefit from usage of the EGEE compatible GRID testbed because of the need of powerful computing resources. It calculates the energy flux and normalized to the continuum stellar spectrum that are applied for stellar classification and determinations of e.g. chemical compositions, effective temperatures and surface gravities of stars. The specific energy flux modeling is an important tool for analysis of data, which will be produced by the European Space Agency's GAIA space observatory.

Fig. 1. The upper part of the window (main SYNTSPEC application window) corresponds to the external php script for variation of input parameters. User should choose a model, wavelenght range, calculation step, microturbulent velocity parameter, convolution profile FWHM and function, abundance extremes and step, abundances of other elements, Van-der Vaals parameters. The lower part internal GRIDCOM launching system where name of work and number of jobs are required for launching.

Fig. 2. The interval of synthetic spectrum examples at 330 - 1050 nm for stars with (T, log g, [Fe/H]) equal to: (6400, 2.2, 0.0), (5700, 4.4, 0.0) and (4200, 2.0, 0.0) from the top downwards. The output is compatible to Virtual Observatory tools. The SPLAT-VO software is used for the visualization.

Impact:

The special added value is the implementation of the energy flux modeling, which makes an application ready for processing of very specific data from GAIA and other modern observatories. The application itself is produced under Gridcom interface on the BalticGrid Special Interest Group site (http://sig.balticgrid.org). Integration with the Gridcom graphical interface makes the application usage much more intuitive for users and enables the group work of scientists independently of their physical location. The BalticGrid-II project established the production-level, interoperable and complementary with the EGEE grid infrastructure, providing to scientists in the Baltic States and Belarus the access to critical resources, supporting the effective research collaborations and sharing efficiently unique instruments and data (for more information see Tautavaišienė et al. 2009 a, b). The SYNTSPEC application benefits from the usage of large project resources, which makes possible the calculation of synthetic stellar spectra for significant wavelength ranges which is essential for the galactic and stellar research studies. The running of the application within the Gridcom interface, improved the job submission procedures and possibilities of user interaction. The application can be submitted and analyzed by a spread group, which is especially important in the remote teaching or analysis of data (for futher information see Juozapavicius & Piatov 2008).

GRIDIFICATION

The gridification of the application was performed at the Institute of Theoretical Physics and Astronomy of Vilnius University. It is set by FORTRAN and C++ coded programs joined together by scripts. Parametric submission is performed by GRIDCOM interface. A single job runs for 8 – 10 hours. About 50 jobs are required to derive the main parameters of a star and about 15 jobs for determining of the chemical abundances of every other chemical element. In general it takes to run more then 400 jobs for one star. The output is not very huge, but bigger amount of temporary memory in every single node is required. Depending on the initial atomic database, the program stores more then 100 GB temporary space. The output follows VOTABLE standards to be compatible within the Virtual Observatory infrastructure.
The GRIDCOM itself is a Simple Grid User Interface for Complex Applications it automatically generates as many jobs as it is needed, launches them on a grid, resubmits aborted jobs automatically and without a user computer turned on, collects the results and do any other actions required. The system itself is a server with gLite UI installed. Each application is in fact a Linux command-line application, and the application controlling code is a regular Linux executable code. Each application is launched in a directory, which is accessed via the HTTP protocol, so every file, created by an application, automatically has its own URL. Applications are free to publish different HTML files and PHP scripts for controlling the application, placing links to files, showing different Java or ActiveX result viewers. This makes the system very simple, reliable, flexible and powerful.

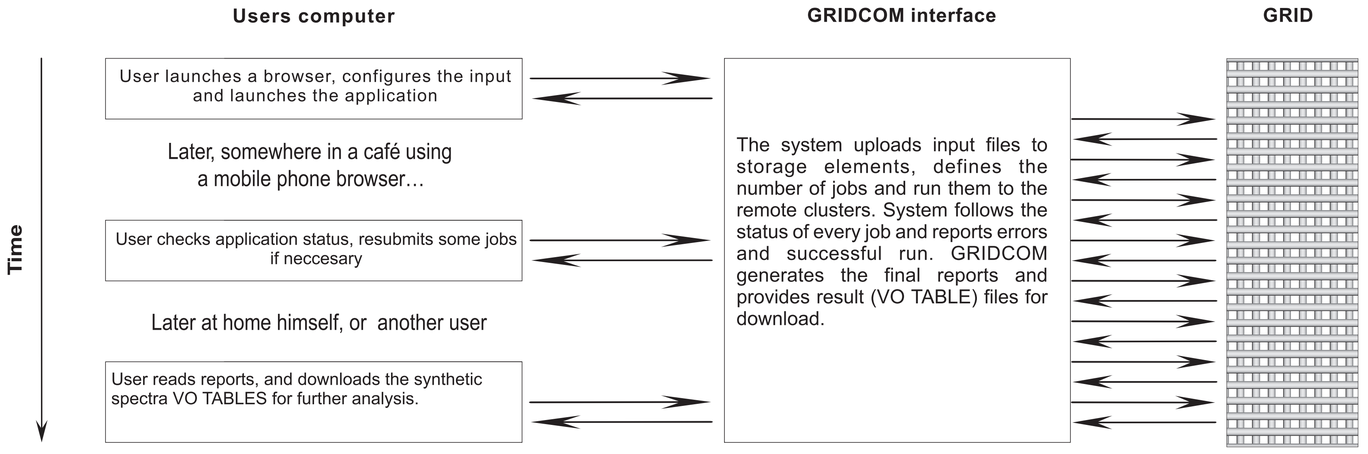

Fig. 3. The principle of an operation for launching SYNTSPEC application on the GRID infrastructure by the GRIDCOM interface.

References

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