Compact and Handy FORTRAN Code SMART for Physics of Stellar Atmospheres

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A new computer code SMART (**S**pectra from **M**odel **A**tmospheres by **R**adiative **T**ransfer) for computing the stellar spectra, forming in plane-parallel atmospheres, has been compiled by us and A. Aret. To guarantee wide compatibility of the code with shell environment, we chose FORTRAN-77 as programming language and tried to confine ourselves to common part of its numerous versions both in WINDOWS and LINUX. SMART can be used for studies of several processes in stellar atmospheres. The current version of the programme is undergoing rapid changes due to our goal to elaborate a simple, handy and compact code.

Instead of linearisation (being a mathematical method of recurrent approximations) we propose to use the physical evolutionary changes or in other words relaxation of quantum state populations rates from LTE to NLTE has been studied using small number of NLTE states. This computational scheme is essentially simpler and more compact than the linearisation. This relaxation scheme enables using instead of the Λ-iteration procedure a physically changing emissivity (or the source function) which incorporates in itself changing Menzel coefficients for NLTE quantum state populations. However, the light scattering on free electrons is in the terms of Feynman graphs a real second-order quantum process and cannot be reduced to consequent processes of absorption and emission as in the case of radiative transfer in spectral lines.

With duly chosen input parameters the code SMART enables computing radiative acceleration to the matter of stellar atmosphere in turbulence clumps. This also enables to connect the model atmosphere in more detail with the problem of the stellar wind triggering.

Another problem, which has been incorporated into the computer code SMART, is diffusion of chemical elements and their isotopes in the atmospheres of chemically peculiar (CP) stars due to usual radiative acceleration and the essential additional acceleration generated by the light-induced drift.

As a special case, using duly chosen pixels on the stellar disk, the spectrum of rotating star can be computed. No instrumental broadening has been incorporated in the code of SMART.

To facilitate study of stellar spectra, a GUI (Graphical User Interface) with selection of labels by ions has been compiled to study the spectral lines of different elements and ions in the computed emergent flux.

An amazing feature of SMART is that its code is very short: it occupies only 4 two-sided two-column A4 sheets in landscape format. In addition, if well commented, it is quite easily readable and understandable. We have used the tactics of writing the comments on the right-side margin (columns starting from 73).

Such short code has been composed widely using the unified input physics (for example the ionisation cross-sections for bound-free transitions and the electron and ion collision rates). As current restriction to the application area of the present version of the SMART is that molecules are since ignored. Thus, it can be used only for luke and hot stellar atmospheres.

In the computer code we have tried to avoid bulky often over-optimised methods, primarily meant to spare the time of computations. For instance, we compute the continuous absorption coefficient at every wavelength. Nevertheless, during an hour by the personal computer in our disposal AMD Athlon XP 1700+, 512MB DDRAM) a stellar spectrum with spectral step resolution $\lambda/d\lambda = 3D100\ 000$ for spectral interval 700 – 30 000 Å is computed.

The model input data and the line data used by us are both the ones computed and compiled by R. Kurucz. In order to follow presence and representability of quantum states and to enumerate them for NLTE studies a C^{++} code, transforming the needed data to the LATEX version, has been compiled. Thus we have composed a quantum state list for all neutrals and ions in the Kurucz file 'gfhyperall.dat'. The list enables more adequately to compose the concept of super-states, including partly correlating super-states.

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