1. Introduction

This paper deals with the performances and the results obtained for large astrophysical problems (macro-program codes) implemented to the library of the computational system of the Astronomical Institute of the Romanian Academy. These problems concern:

- stellar structure and evolution,
- stellar pulsation and seismology,
- N-body simulations.

The computational system of the Astronomical Institute of Romanian Academy consists of one superscalar computer (SGI POWER CHALLENGE M, with 1CPU, R8000/75Mhz processor, 300 Mflops SPECfp92, 64Mb RAM, 2Mb Cache) and a workstation (INDY, with 1CPU, R4400 SC/150Mhz processor, 93Mflops SPECfp92, 64Mb RAM, 1Mb Cache). In order to accelerate the calculus on SGI Pw.Ch.M, both computers share the same 24-bit XL graphic card on the INDY workstation using FDDI connection.

In this paper some symbolic processes that improve the high-performance computing are also presented:

- optimization of the user (calculations) processes and compilator processes;
- vectorization.
2. Models for stellar structure and evolution and for stellar seismology

The sets of equations used in the model of stellar structure and evolution are of 1-D type (Henyey model). The sets of equations used in the models of stellar seismology and pulsation are of 3-D type. These equations are linearized using small eulerian and lagrangian perturbations. The full model was described in Suran 1993.

By discretization we obtain the numerical equations involved in computer calculations. In the case of stellar structure and evolution the sets of equations can be wrote in the form of a linear system of equations:

\[ \frac{dY_i}{dr} = A^{i+1/2}y_i, \quad (i = 1, N) \tag{1} \]

which can be solved using a HENYEY method of inversion of large REAL SINGLE PRECISION matrices \( A^{i+1/2} \) of dimension \( N \times N \) (where typical \( N = 300-3000 \)).

In the case of stellar seismology and pulsation the solution of the equations can be described in the form of a linear system of equations:

\[
\begin{aligned}
\phi B^{i+1/2} + \alpha_i \rightleftharpoons y_i + (1 - \phi) B^{i+1/2} - \alpha_{i+1} y_i &= 0 \\
\omega_{i+1/2} &= \left[ \omega_{i+1} D_i(\omega, y) - \omega_i D^{i+1}(\omega, y) \right] / \left[ D_i(\omega, y) - D^{i+1}(\omega, y) \right]
\end{aligned}
\]

which can be resolved using a predictor-corrector method for the first equations, with a HENYEY- FEAURTRIE method for large matrices \( B^{i+1/2} \) of dimension \( N \times N \), with:

- REAL DOUBLE PRECISION variables in the adiabatic case \( (\delta S = 0) \);
- COMPLEX DOUBLE PRECISION in the non-adiabatic case \( (\delta S \neq 0) \);

and a NEWTON secante method for the last equation.

For the calibration of models, we made a comparison between the observational results obtained in the STEPHI multi-site program for \( \delta \) Scuti stars with the theoretical calculations, using our models for stellar evolution and pulsation (the blue limit of the instability strip). This stellar evolutive model is our own Henyey model with \( N \approx 3000 \) and OPAL opacities for stars with \( 1.7M_\odot \sim 2M_\odot \) from pre-MS to post-MS . We used our own code for stellar pulsation, in the \( \delta \) Scuti region \( (l = 0 - 2, |n| < 10) \), in two cases: normal pulsation and pulsation with inert radiative diffusion.

Another problem to investigate is the stability of the pre-main sequence stars of intermediate mass range in the \( \delta \) Scuti region (prototype star: HH star, HR 5999). Our results confirm that the radial and nonradial models