MINISTÉRIO DA CIÊNCIA E TECNOLOGIA
INSTITUTO NACIONAL DE PESQUISAS ESPACIAIS

PROPOSOAL FOR GLOBAL CYBERBRIDGES

Candidate: Renata Sampaio da Rocha Ruiz E-mail: renata@lac.inpe.br
Brazilian advisor: Haroldo Fraga de Campos Velho E-mail: haroldo@lac.inpe.br

Phone: +55 12 3945-6550
Fax: +55 12 3945-6375

LAC: Laboratory for Computing and Applied Mathematics
INPE: National Institute for Space Research (Brazil)

GRID COMPUTING FOR COSMOLOGICAL TURBULENCE

The scientific computing group from the LAC-INPE has recently investigated the Zel'Dovich's (1970) approach, where the cosmological evolution could be described as a turbulent-like dynamics. Therefore, some characteristics verified to the turbulent flow should also be identified for astrophysical scale. One of these features would be the -5/3 Kolmogorov's law.

Several techniques can be used to separate the scales from the astronomical structures, such as clustering analysis, data mining, and artificial neural networks. In our preliminary study, a percolation method (*Friend-of-Friends*) was employed to separate two astronomical structures: galaxies and cluster of galaxies for dark matter halos. This previous analysis would allow us to compute spectra of the gravitational potential energy for each type of astronomical structure, mentioned before. The spectra show the potential energy as a function of the inverse of the radius considered (Caretta et al., 2008).

Data for our analysis came from the intermediate scale cosmological N-body simulations run by the Virgo Consortium (www.virgo.dur.ac.uk). However, this preliminary evaluation considered only a small volume from the total integration domain. As usual, the fundamental properties of the N-body simulations of structure formation in the Universe are defined by the background cosmological model and the initial perturbations imposed on this background. Four versions of the cold dark matter model are available from the Virgo Consortium project, from which we chose the Λ-CDM one (Λ: cosmological constant; CDM: *Cold Dark Matter*). Among the additional (numerical) parameters that characterize the simulation are a simulation box of side 239.5 h^{-1} Mpc (megaparsecs), and the number of particles: 256^3, with individual masses of $6.86\times10^{10}\ h^{-1}M_\Theta$ (h: expansion ratio; $h=H_0/(100$ Km/s); H_0: Hubble constant; M_Θ: solar mass ~ 1.98892×10^{30} Kg).

The goal here is to extend the analysis for a bigger domain from the Virgo Consortium data.

Figure 1 shows an example of three possible regions for the analysis (from Virgo consortium and an observational astronomical image). The computation involved in this analysis is intensive, because we are going to study several sub-domains. Therefore, some computational strategy/environment should be used in order to improve the calculation. We are designing an astrophysical grid to perform the computation employing the OurGrid middleware (www.ourgrid.org). Institutions and/or Departments that accepted to participate of this grid: Laboratory for Computing and Applied

Mathematics, Astrophysics Division (both from the INPE), the Astronomy Departments from MacKenzie University (Brazil) and Guanajuato University (Mexico).

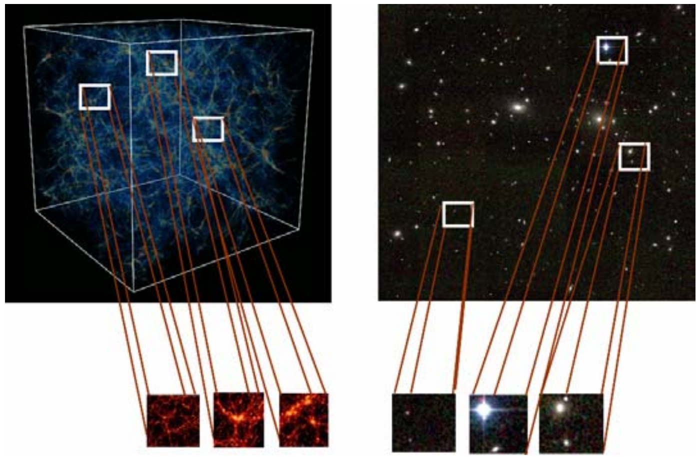

Figure 1: Example of data for astrophysical grid: (a) Virgo simulation; (b) observed astronomical image.

The goal of this proposal is start the astrophysical grid to verify the gravitational energy spectra for different sub-domains, all of them will be boxes of side 239.5 h^{-1} Mpc. Figure 2 shows the gravitational spectra for several redshits (z). For computing spectra for data from observational astronomy records is more difficult than simulated data.

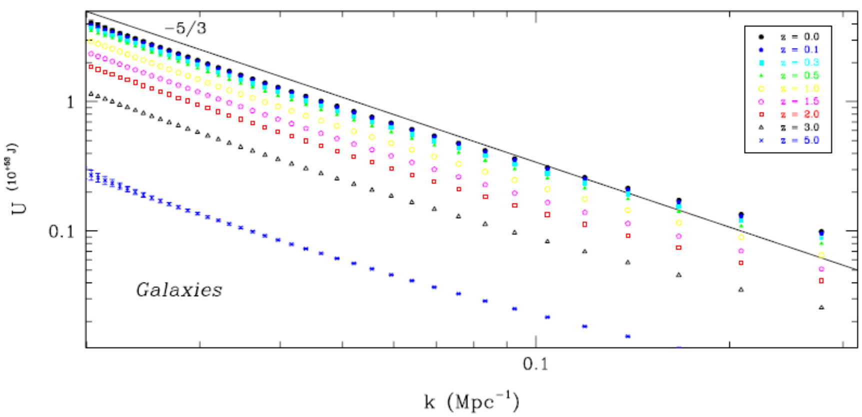

Figure 2: Gravitational energy spectra $U(k)$ for galaxy-sized haloes, for the sampled redshifts. A reference −5/3 power law is plotted as a solid line (Caretta et al., 2008).

REFERENCES:

C. Caretta, R.R. Rosa, H.F. Campos Velho, F.M. Ramos: *Astron. Astrophys.*, **487**, 445-451, 2008.

Ya.B. Zel'Dovich: *Astron. Astrophys.*, **5**, 84-89, 1970.