The Italian participation in the COROT asteroseismological experiment

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ABSTRACT

We shortly review some aspects of the Italian participation in the asteroseismological work to prepare the COROT mission.

1. The previous Italian approach to the asteroseismological space missions

The Italian interest in the development of an asteroseismological space mission dates back to the late eighties. In particular, it was proposed to put an Optical Monitor onboard the satellite Spectrum X-Gamma, in parallel with the JET-X telescope. In addition to the optical observations of the X-ray sources, such an instrument would have been able to perform asteroseismological studies, in a serendipity mode, of the stars located in the field of view (Antonello et al. 1994). Unfortunately, the installation of such a powerful Optical Monitor onboard the Spectrum X-Gamma satellite was cancelled in 1995 owing to schedule problems; a decision which now appears to be grotesque considering the great delay in the launch date.

Other involvements were related to missions such as PRISMA, STARS and STOP, but they remained in the Preparatory Phase. However, the knowledge matured in these experiences can now be useful in the preparation of the COROT mission.

2. The Italian Institutes involved

There are several Italian Institutes involved in the preparation of the scientific background essential for exploiting the capabilities of the COROT space mission. Table 1 lists them, giving the total number of scientists (PhD students included); of course this number may vary in the near future following the normal development of the activities. Table 1 is based on the proposal submitted to the Agenzia Spaziale Italiana (ASI, Italian Space Agency) in July 2000; the aim was not only to provide fundings for the scientific activities, but also to place some industrial contracts, especially for the electronic parts of the instrument.

The ASI has recently answered to our proposal positively; therefore, we are confident to finalize the Italian participation in a near future.

3. The participation in specific themes

The Institutes listed in Tab. 1 are working on some specific themes related to asteroseismology.

Institute	Number Scientists
Osservatorio Astronomico di Brera	10
Osservatorio Astronomico di Padova	2
Osservatorio Astronomico di Roma	4
Osservatorio Astrofisico di Catania	9
Osservatorio Astronomico di Napoli	12
Osservatorio Astrofisico di Arcetri	1
Osservatorio Astronomico di Padova	2
Università di Padova	3
Università di Pisa	2
Università di Roma - Tor Vergata	1
Università di Roma - La Sapienza	1
Università di Catania	3
Istituto Astrofisico Spaziale - Frascati	4

Table 1: Italian institutes involved in the preparation of the COROT mission.

Theoretical models - Particular effects on theoretical models are investigated by different teams located in Padova (chair: C. Chiosi), in Roma (chair: F. D'Antona) and in Catania (chair: L. Paternò). This approach will include the evaluation of the turbulence and convection effects. The application of the new Full Spectrum of Turbulence (FST) models to different evolutionary phases has been found to be promising (D'Antona et al. 1997) and these models will be critically tested by the COROT results. In stars hotter than the Sun, COROT will provide the possibility to compare the different predictions of the FST and of the Mixing-Length Theory about the efficiency of the (subatmospheric) convection, providing a fundamental benchmark between these two models. A group chaired by F. D'Antona is already working on this point.

Napoli, Roma and Firenze scientists (G. Bono, M. Marconi, V. Ripepi and F. Palla) are working on models of pre-main-sequence pulsating stars (Marconi & Palla 1998; Bono et al. 1997). Therefore, the oscillation properties will be used to probe the structure of stars which are also in this evolutionary phase, only recently considered as a domain of the pulsation theory.

Additional Programmes - The possibility to investigate other classes than δ Scuti and solar-like stars is a good opportunity offered by COROT. In this framework, Brera Observatory (E. Poretti and F. Zerbi) is collaborating with Nice, Wien and Leuven teams (just to mention teams of the COROT consortium) to ensure an observational survey of the γ Dor stars, i.e. the g-mode pulsators which constitute an interesting link between the two classes quoted above (Zerbi 2000). Both photometric and spectroscopic observations are planned on γ Dor stars to identify new targets. The COROT observations should allow an improvement of the phenomenological scenario (periods of about 1 d and amplitudes of a few mmag are hardly detectable from the ground) and, together with the physical parameters of the stars, a study the relations between convection and pulsation.

The Napoli team is also interested in the observational and theoretical study of white dwarfs and related objects (pre-WDs, both post-AGB and Extreme Horizontal Branch stars). In particular, the long time baseline will also allow the detection of amplitude variations due to nonlinear effects, hardly recoverable from multisite campaigns (Silvotti et al. 1999). When white dwarfs are in binary systems, they can originate a cataclysmic variable from the matter falling from the companion filling its Roche lobe. The study of the power spectra provides important clues both on stellar parameters as well as on accretion geometry and emission processes (De Martino et al. 1999).

Constraints in terms of stellar structure and Data Reduction - The analysis of simulated light curves to extract periodicities and/or frequency spacings in the data is the goal of dedicated hare and hounds exercises. In this context, scientists from Brera Observatory (M. Bossi, L. Mantegazza, S. Martín) are already working on the subject, which has some contact points with a similar topic proposed for the MONS experiment. The aim is to develop an optimal approach to detect and type the oscillation modes, to derive their damping times and to evaluate the true stellar rotational velocity.

Stellar Activity - COROT can monitor the activity level of solar-type stars not only to detect oscillations, but also to constrain the models of coronal heating by evaluating the amplitude statistics of flares, to derive the parameters of differential rotation, to derive the photospheric coverage of spots in function of the physical parameters of stars, to study the stellar spot life and migration times. In this field the Catania team has a long experience on the matter (Lanza et al. 1994, Marino et al. 1999, Cutispoto 1998, Rodonò et al. 1995).

Characterization of the targets - In addition to the spectroscopic and photometric survey of the 1200 stars included in the two COROT scenarios (Ground Based Observations Working Group), observational campaigns are necessary to give a more detailed picture of the pulsational properties of δ Scuti stars. Photometric campaigns on the main targets before the mission may give a first idea of the richness of the pulsational content, which can be very different from one star to another (Poretti 2000). The observations of the same targets after the mission can be useful to ensure a better frequency resolution. Of course, that is valid only for modes having amplitudes at the mmag level. The spectroscopic campaigns will be particularly useful since they can provide information complementary to the very deep photometric approach guaranteed by COROT. Therefore, the Brera team intends to continue their observational effort (photometric and spectroscopic) in this field, providing observational quantities for the Main Targets (see Poretti & Mantegazza 2001). A useful contribution to this field is also offered by the availability of the Catania Automatic Telescope, especially for dedicated campaigns (G. Cutispoto and I. Pagano).

REFERENCES

Antonello E., Citterio O., Perenzoni A., Poretti E.: 1994, *Optical Monitor of JET-X on Spectrum-X-Gamma*, Proc. SPIE, San Diego, July 1994, Vol. 2279, 504

Bono G., et al., 1997, ApJ 477, 346

Cutispoto G., 1998, A&AS 131, 321

D'Antona F., Caloi V., Mazzitelli I., 1997, ApJ 477, 519

De Martino D., Silvotti R., et al., 1999, A&A 350, 517

Lanza A.F., Rodonò M., Zappalà R.A., 1994, A&A 290, 861

Marconi M., Palla F., 1998, ApJ 507, L141

Marino G., Rodonò M., Leto G., Cutispoto G., 1999, A&A 352, 189

Poretti E., 2000, in "Delta Scuti and Related Stars", M. Breger and M. Montgomery Eds, ASP Conf. Ser., vol. 210, 45

Poretti E., Mantegazza L., 2001, these proceedings

Rodonò M., Lanza A.F., Catalano S., 1995, A&A 301, 75

Silvotti R., Dreizler S., Handler G., Jiang X., 1999, A&A 342, 745

Zerbi F.M., 2000, in "Delta Scuti and Related Stars", M. Breger and M. Montgomery Eds, ASP Conf. Ser., vol. 210, 332