Istituto Nazionale di Fisica Nucleare

Laboratori Nazionali del Gran Sasso

A first look at the Earth interior from the Gran Sasso underground laboratory

Another demonstration of the very high level of the Gran Sasso National Laboratory research. The Borexino experiment at the underground laboratory of the *Istituto Nazionale di Fisica Nucleare* (INFN, Italy's National Institute of Nuclear Physics) in Gran Sasso has observed particles produced deeply in the Earth, where the planet's heat is generated. The study will be published on-line at the website arXiv.org.

The Borexino Collaboration (which includes various institutions from Italy, US, Germany, Russia, Poland and France- spokesman Professor Gianpaolo Bellini of the INFN in Milan), have observed for the first time geo-neutrinos, which are anti-neutrinos (the smallest and most elusive anti-matter) produced in radioactive decays of Uranium, Thorium and Potassium, thousands of kilometers below the Earth Crust. These decays give a major contribution to the enormous heat contained in our planet, which produces convective movements in the Earth mantle, strictly connected to the volcanic activity, to the plates movements and to the geo-dynamo (which is connected to the Earth magnetic field).

The detection of the geoneutrinos is an important proof that the radioactivity is the main source of the Earth heat, more than 50%, but perhaps 100%; the number of geoneutrino interactions accumulated until now is no yet enough to discriminate with precision between the different hypotheses. Nevertheless it is possible, since now, to disprove the theory that, at the centre of the Earth, nuclear reactors are responsible for the planet heating

With experiments such as Borexino in various sites of the planet, it will be possible to determine the quantity of radioactive materials on the Earth and perhaps to identify precious deposits of nuclear fuel.

Although a Japanese experiment had previously obtained an experimental hint for geo-neutrinos, the detector used by these researchers was located too close to nuclear power plants, which produce a lot of antineutrinos, interfering with the detection of geoneutrinos . At Gran Sasso, located at 500 km from the nearest nuclear power plant, it is possible to detect a genuine signal of the Earth's natural radioactivity. Furthermore the unprecedentedly very low radioactivity, reached by Borexino, by means of new technologies developed on purpose, greatly contributed to this success.

For Professor Gianpaolo Bellini “This discovery marks the beginning of a new era in the study of the mechanisms that govern the interior of the Earth." "An extended study of geo-neutrinos at various sites on the Earth...", continues Bellini "...will provide more precise information on the heat produced by the Earth's mantle and thus on the convective motions underlying volcanic

phenomena. tectonic movements, and on the geo-dynamo, which has connections with the Earth magnetic Field. The success of this study, in addition to the distance of Gran Sasso from nuclear power plants, was made possible by the new technologies that we have developed at the Gran Sasso Laboratory, which have allowed to reach levels of purity in terms of radioactive elements never achieved before by anyone".

"The extraordinary results of the Borexino experiment" – affirms Lucia Votano, Director of the Gran Sasso National Laboratories – "are the reward of years of intense work and were made possible by the characteristics of our underground laboratory, which is unique in the world, and by the extreme radio-purity of the materials used for the experimental apparatus. The experiment had already been providing important information on the inner works of the Sun and now it has produced the world's first measure of geo-neutrinos coming from the depths of our planet. Once again the Gran Sasso Laboratories have proven to be a research centre of excellence in the field of Astroparticle Physics."

"Borexino has opened a new window which allows us to look straight into the interior of the Earth, to a depth of up to thousands of kilometers." – states Giovanni Fiorentini, Coordinator of a research team of the INFN and the University of Ferrara which developed the first theoretical models of geo-neutrinos – "The comparison of experimental data and the theoretical models will throw some light onto the chemical composition and origins of the Earth". Moreover, the level of radio-purity of Borexino, never before achieved by anyone, has greatly contributed to this success.