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Studying the Earth's heat budget with geoneutrinos

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The Earth is cooling down and its surface heat flux is the highest among all the terrestrial planet of the Solar System. The total heat loss (Q) is due to the energy released by the secular cooling of our planet (C) and of the radiogenic heat (H) produced by the radioactive decays of the radioelements contained therein. Can geoneutrino disentangle these two contributions?

Since while decaying, the uranium, thorium and potassium radioisotopes contained in the Earth release geoneutrinos in a well-fixed ratio, we can attempt to answer affirmatively to this question. Indeed, geoneutrinos are able to pass through most matter without interacting, so they can bring to surface useful information about the Earth' deep interior. Concretely, measuring the geoneutrino flux at surface hence translates in estimating H and in turn constraining C once that Q is known.

The only two experiments which collected data in the last 15 years are KamLAND (Japan) and Borexino (Italy). By combining theoretical models and experimental flux with a sophisticated analysis, we inferred valuable insights on mantle radioactivity and of contribution of H to the Earth's energy budget. We estimated a total radiogenic heat accounting for H = $20.8^{+7.3}_{-7.9}$ TW and, by subtracting this value from the total heat power of the Earth, we derived a secular cooling C = 26 ± 8 TW. The obtained results are discussed and framed in the puzzle of the diverse classes of formulated Bulk Silicate Earth models, analyzing their implications on planetary heat budget and composition.

The effectiveness in investigating deep earth radioactivity demonstrated by geoneutrino studies confer them a prestigious role in the comprehension of geodynamical processes of our planet.