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New experiment searching for solar axions with Tm-containing cryogenic bolometer

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Intensive experimental searches for axions and axion-like particles (ALPs) are currently supported by two main circumstances: first, axions solve the strong CP problem and, second, axions are well-motivated candidates for the role of dark matter particles. Moreover, the existence of axions and ALPs could explain too rapid cooling some classes of stars and the anomalous transparency of the Universe for γ-quanta with energies of the order of 1 TeV.
If axions do exist, then the Sun should be an intense source of these particles. Axions can be efficiently produced by Primakoff conversion of photons in the electric field of the plasma, by Compton and bremsstrahlung like and atomic processes in the hot solar plasma. The resulting axion fluxes depends on axion-photon $g_{A\gamma}$ and axion-electron g_{Ae} coupling constants, respectively, and can be detected via the resonant excitation of low energy nuclear levels. The searches for the resonant absorption of solar axions by ^{169}Tm nuclei A + ^{169}Tm $\rightarrow$ ^{169}Tm*(8.41 keV) $\rightarrow$ ^{169}Tm + (γ-, e-) were proposed and carried out in [1, 2].
In this work we used the $Tm_3Al_5O_{12}$ crystal as cryogenic bolometer [3] to detect the X- and γ-rays, conversion and Auger electrons appearing due to de-excitation of 8.4 keV nuclear level of ^{169}Tm. Measurements carried out with 8 g crystal for 6.6 days on the surface of the earth allowed to establish new limits on the coupling constants of the axion with photons, electrons and nucleons g_{AN}: $|g_{A\gamma}(g_{0AN}+g_{3AN})| \leq 1.44\times10^{-14}$ GeV^{-1} and $|g_{Ae}(g_{0AN}+g_{3AN})|$ 2.81×10^{-16}. The obtained restrictions excluded a new range of possible values of the coupling constants $g_{A\gamma}$ and g_{Ae} and axion masses m_A [4].

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