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Magnetic-field models and constraints on axion-like paricles from the lack of irregularities in high-energy spectra

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Photons may convert to axion-like particles (ALPs) in external magnetic fields. Under certain conditions, this effect should result in irregular features in observed spectra of astrophysical sources. Lack of such irregularities in particular spectra was used to constrain ALP parameters, with two most popular sources being the radio galaxy NGC 1275 and the blazar PKS 2155-304. The effect and, consequently, the constraints, depend on the magnetic fields through which the light from the source is propagated. Here, we revisit ALP constraints from gamma-ray observations of NGC 1275 taking into account the regular magnetic field of the X-ray cavity observed around this radio galaxy. This field was not accounted for in previous studies, which assumed a model of purely turbulent fields with coherence length much smaller than the cavity size. For the purely regular field, ALP constraints are relaxed considerably, compared to the purely turbulent one. Similar arguments hold also for PKS 2155-304. While the actual magnetic field around a source is an unknown sum of the turbulent and ordered components, the difference in results gives an estimate of the theoretical uncertainty of the study and calls for detailed measurements of magnetic fields around sources used to constrain ALP properties in this approach.

Primary author: Prof. TROITSKY, Sergey (Institute for Nuclear Research, Russian Academy of Sciences (RU))

Co-author: Prof. LIBANOV, Maxim (Institute for Nuclear Research of RAS)

Presenter: Prof. TROITSKY, Sergey (Institute for Nuclear Research, Russian Academy of Sciences (RU))

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