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# Searching for the Anomalous Internal Pair Creation in $^{8}$Be (online)

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Since the Rose model was published in 1949 [1,2], several laboratories worldwide have started experimental campaigns to measure the angular distribution of the Internal Pair Creation (IPC) process in light nuclei to study electromagnetic multipole transitions. In the 1950s, Devons et al. reported the experiments' results in $^{16}$O, $^{8}$Be, and $^{8}$Be [3,4]. The angular correlations obtained were consistent with the Model of Rose (adding an anisotropy due to Coulomb field effects). But in 2016, Krasznahorkay et al. reported the breakthrough of an anomaly in the IPC of $^{8}$Be~[5]. An unexpected angular correlation distribution in the emission of the pair $e^+e^-$ was found in the isoscalar magnetic dipole transition (18.15 MeV state ($J^\pi = 1^+$, T=0) $\rightarrow$ ground state ($J^\pi = 0^+$, T=0)). According to theoretical calculations performed with the Rose model, the angular correlation distribution drops quickly with the relative separation angle of the leptons. In contrast, the Hungarian group reported a peak-like behavior at large angles~[5]. This result has been interpreted as the signature of the emission of a previously unknown neutral isoscalar particle, named X17, with a mass of 16.70$\pm$0.35(stat)$\pm$0.5(syst) MeV/c$^2$ and $J^\pi$=1$^+$.

The present talk describes the historical events of the efforts to study this phenomenon and provides an overview of the experimental facilities that have been built up to now. As a particular case, the design and construction of a dedicated array to study this anomaly at the Laboratori Nazionale di Legnaro (Istituto Nazionale di Fisica Nucleare, Italy)~[6] are presented. The project aims to measure the angular correlation distribution of the emission of the pair $e^+e^-$ from the transition studied in $^{8}$Be at the Atomki Laboratories. The detector unit is a telescope manufactured with the plastic scintillator EJ-200. The in-beam commissioning of the setup demonstrated that the array could measure the lepton pairs in coincidence and reconstruct the energy of the electromagnetic transition.

Furthermore, the $\Delta$E layer consists of a system of a double layer of 10-bars designed to detect the incident position of the particles. The IPC of the transition $0^+ \rightarrow 0^+$ in $^{16}$O has been studied as a first case. This transition is used as a calibration point of the detectors since the cross-section is orders of magnitudes higher than the one in $^{8}$Be. In November 2023 and May 2024, the former experiments were carried out at the AN2000 Accelerator. LiF targets from 50-950 $\mu$m/cm$^2$ have been irradiated with a 0.440-1.09 MeV proton beam and a $\sim$500 nA current. The population of the state of interest and the integrity of the target were monitored with a 3$\times$3 in$^2$ $LaBr_3$ detector.

References

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