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Positron interactions with natural and synthetic chiral quartz crystals in non-z orientations

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The interactions of energy and particles in asymmetric substances has been of fundamental research interest since the discovery of chirality [1]. A well-studied asymmetric crystalline material is α-quartz [2], which has a helical structure associated with its crystallographic z-axis. Previously, we reported a large difference in 'free positron' annihilation lifetime and intensity between samples of LH and RH quartz single crystals [3]. In the current project, we investigated natural versus synthetic quartz in z and non-z orientations using PALS to confirm asymmetric interactions and to compare different orientations. As before, we observed significant lifetime and intensity differences in free positronium annihilation for LH and RH quartz crystals (Figure 1). The trend was also found to be the same for the similar crystallographic orientations of LH or RH crystals; that is, the direction of incident positrons, z or non-z, did not affect the observed differences in lifetime and intensity trends. The results are attributed to differential interactions of positronium with the asymmetric lattice structures of LH and RH quartz. This result may point to the positron or positronium species being sensitive to the small electroweak energy difference between enantiomers [4]. Further, the results may be considered an example of particle stereo-recognition.

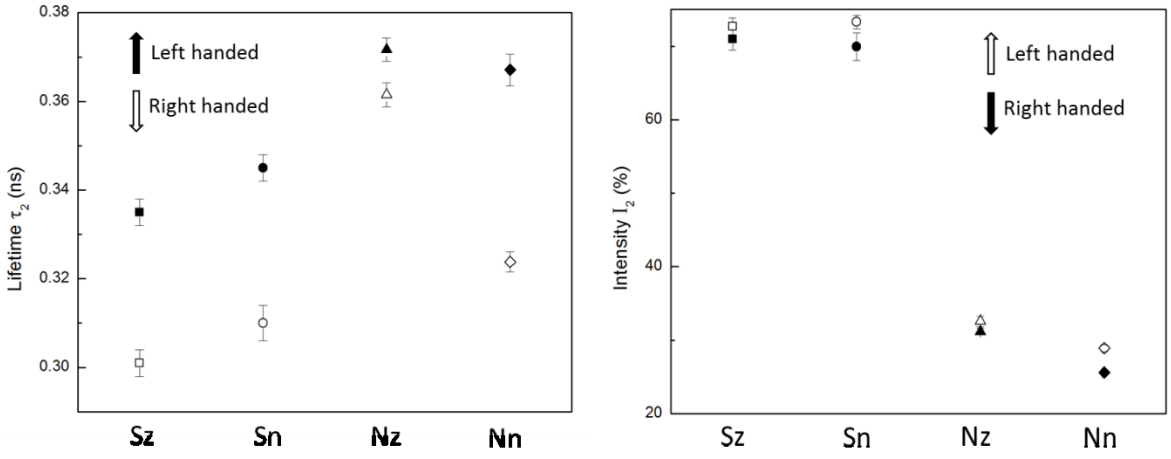

Fig.1. Lifetime and intensity differences in 'free positron' annihilation for LH and RH chiral crystals. **S** / **N** / **z** / **n** represent synthetic and natural quartz, and the *z* and non-*z* crystal orientations, respectively.

[1] L. Pasteur, *CR Hebd. Acad. Sci.,* **26**, 535 (1848).
[2] H. Saito and T. Hyodo, *Phys. Rev. Lett*., **90**, 19 (2003).
[3] J.D. Van Horn, F. Wu, G. Corsiglia and Y.C. Jean, *Def. Diffus. Forum*, **373**, 221 (2016).
[4] R. Bast, et al., *Phys. Chem. Chem. Phys.*, **13**, 865 (2011).