**Measuring the Angular Momentum of a Neutron Using Earth’s Rotation**

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The Angular Momentum (AM) of a quantum particle is defined as the sum of an intrinsic part, called spin and an extrinsic or structural part known as Orbital Angular Momentum (OAM). For neutrons OAM is a unique quantum mechanical degree of freedom, as OAM is discrete and can take on any integer value. This means OAM could be used as a qudit, which is thought to have a far wider range of application than standard qubits in quantum information [1]. In addition, various authors suggest that twisted waves have different scattering properties, suggesting that twisted neutrons may be useful for nuclear physics [2,3].

Up until the last decade OAM was mostly neglected in neutron optics. In 2015 a first attempt was made to generate neutron OAM in a perfect crystal interferometer [4]. However, only in 2022 were the first helical neutron waves produced on the tail end of the cold spectrum [5]. Nonetheless, many challenges remain, such as efficiently generating OAM on the thermal/cold peak and efficient detection of OAM.

In this talk we discuss our work which attempts to address the latter issue [6]. It is well known that the laws of nature appear to work differently in non-inertial frames. An example of such is the apparent coupling between the AM of a test particle and the rotation rate of the frame of reference in which it is observed. This is known as the Sagnac effect [7]. We present and discuss an experiment where the Sagnac effect, arising due to Earths rotation, is used to detect the OAM difference between two path states in a Spin-Echo interferometer. Finally, we argue, that the discrete/quantum Sagnac effect may be detected in our setup by speeding up the rate of rotation, by means of a neutron optical dove prism.

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