Contribution ID: **15** Type: **polarized neutron techniques and methods**

# Measuring the Angular Momentum of a Neutron Using Earth ' s Rotation

*Monday, 24 February 2025 16:30 (30 minutes)*

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.

[1] T. Giordani et al., PRL 122, 020503 (2019).
[2] A.V. Afanasev et al., Phys. Rev. C, 103, 054612 (2021).
[3] T. Jach and J. Vinson, Phys. Rev. C, 105, L061601 (2022).
[4] C.W. Clark et al., Nature, 525, 504 (2015).
[5] D. Sarenac et al., Sci. Adv., 8, eadd2002 (2022).
[6] N. Geerits et al., arXiv:2407.09307 (2024).
[7] M.G. Sagnac, Comptes Rendus, 157, 708 (1913).

**Primary author:** GEERITS, Niels (TU Wien)

**Presenter:** GEERITS, Niels (TU Wien)

**Track Classification:** Download the latest program here