# The spinorial ball: a macroscopic object of spin-1/2

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The existence of spin-1/2 particles is one of the most striking features of quantum mechanics and is often described as 'an object that does not come back to its initial state after one turn but that does after two turns'. Such feature has no straightforward equivalent in our macroscopic world and is therefore often considered as puzzling for the intuition. To provide better understanding, several macroscopic demonstrations have been proposed, the most famous one being the 'Dirac belt trick'. Alternatively, half integer spin can also be mapped on coupled pendulums in some specific parameter space [1]. However, a direct physical implementation of a half-integer spin in three dimensions without constraints is still missing.

We propose here to fill this gap by introducing the spinorial ball. It consists of a translucent plastic ball with internal gyroscope and LED illumination that behaves as a free-to-move macroscopic spin-1/2 object. It provides a new pedagogical tool to introduce spin-1/2 but also to the covering group homomorphism from SU(2) (the rotation group of spinors) to SO(3) (the rotation group in physical space). This device offers in particular a clear visualization of the different homotopy classes of SO(3). The embedded electronics also allow the ball to mimic quantum measurement and wave function collapse. The entire system is open source hardware, with build details, models, 3d printing files, etc., provided under an open source license [2], and a virtual version of the ball can be manipulated online [3].

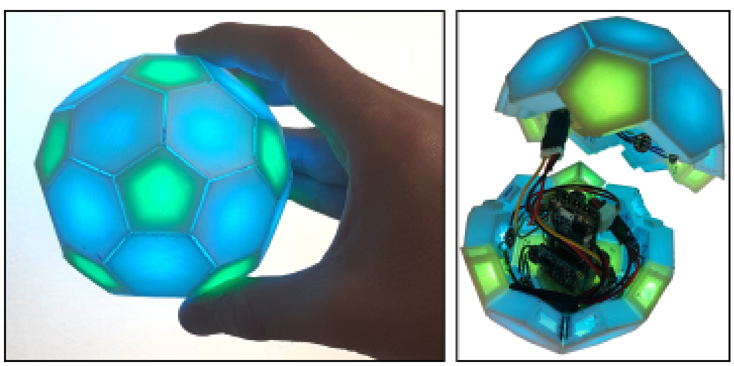

**Figure 1.** Pictures of the spinorial ball: the two color displayed on the LED pannel encode the two complex component of a spinor. An embedded gyroscope detects the physical rotations of the ball and an Arduino changes the colors displayed in order to simulate spin-1/2 evolution under such rotation.

## References

1. Leroy, V and Bacri, J-C and Hocquet, T and Devaud, M, Simulating a one-half spin with two coupled pendula: the free Larmor precession, European Journal of Physics, **6**, (2006).
2. GitHub for the spinorial ball: `https://github.com/heligone/spinorialBall/`
3. Online spinorial ball: `https://dotwave.org/quBall3/`