MATHEMATICS–4H

Project code:	CDC2010:1
Project title:	The Foucault Pendulum.
Supervisor:	Dr. C. D. Coman
Subject area:	History of Science/Mechanics.
Prerequisites:	A-Level Physics (some '*Dynamics 1*' might help, but is not essential).
Summary:	The project will explore Léon Foucault's famous experiment and the cultural/social background of the time. A familiarity with some basic astronomy and the mechanics of pendula will also be expected.

PROJECT DETAILS

"He was neither a mathematician nor a trained physicist and yet Léon Foucault always knew that a mysterious force of nature was among us. Like Newton, Galileo, Copernicus, and others before him, Foucault sensed a dramatic relationship between the rotating skies above and the seemingly motionless ground beneath our feet. But it was not until 1851 – in Paris, inside the Panthéon, and in the company of fellow amateur scientist Napoleon III – that Foucault swung a pendulum and demonstrated an extraordinary truth about the world: that it turns on its axis" (from [1]).

Jean Bernard Léon Foucault was able to confirm the rotation of the Earth by using a large pendulum. The bob of his pendulum, a 38 centimeters in diameter sphere, was made of brass and weighted 28 kilograms, while its wire was 67 metres long. The Coriolis force, an artifact of Earth's rotation, causes the plane of oscillation of the pendulum to rotate as time goes on, at a constant rate equal to $\omega^* = \omega \sin \lambda$ and period $T = 1 \text{ day}/\sin \lambda$; here, ω is the angular velocity of the Earth and λ denotes the geographical latitude of the pendulum site. These facts can be understood relatively easily and detailed explanations are found in any good mechanics textbook (e.g., see [2]).

There are several ways in which this project can be tackled. A mathematically able student should read for general information [1] (and maybe several chapters from [3]), and then should proceed to explore some interesting mathematical questions that arise in relation to the Foucault pendulum. For instance, why is that the period T stated above is not equal to the rotation period of the Earth? And, what happens if the string of the pendulum is not perfectly inextensible? A student with an interest in geometry can start reading [4] and follow it up with more specialist papers (which I am happy to suggest).

A student who is more interested in the historical aspects of the project can focus mainly on the significance of Foucault's experiment in the context of the 19th-century scientific climate. A discussion of the Scientific Revolution and its main exponents would also be desirable.

References:

[1] A.D. Aczel *Pendulum: Léon Foucault and the Triumph of Science*. Washington Square Press, New York 2003.

[2] J.B. Marion *Classical Dynamics (3rd edition)*. Holt Rinehart & Winston, San Diego 1988.

[3] M.R. Matthews, A. Stinner, C.F. Gauld (eds.) *The Pendulum: Scientific, Historical, Philosophical and Educational Perspectives*. Springer Verlag, New York 2005.

[4] J. von Bergmann, H. von Bergmann *Foucault Pendulum through Elementary Geometry*. American Journal of Physics, vol **75**, 888-892 (2007).