THE SUN'S MAGNETIC FIELD

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The Sun has a strong magnetic field that is responsible for a number of dynamic features such as sunspots and solar flares. The intensity of the magnetic field varies on both short (approximately 11 year) and longer (hundreds of years) timescales. Short bursts of magnetic activity on the Sun can cause the emission of particles that can have a catastrophic effect on orbiting satellites. Furthermore, it is now well established that long-term variations of the solar magnetic field are responsible for variations in the Earth's climate — for example, the latter half of the seventeenth century was a time both of sharply decreased solar magnetic activity and reduced terrestrial temperature ("the litle ice age"). Understanding the Sun's magnetic field is therefore a problem not only of great physical and mathematical interest but one with important consequences for the climate on Earth.

The equations governing the behaviour of the magnetic field in an electrically conducting gas (such as that of the Sun) are those of magnetohydrodynamics (MHD). These are the equations of fluid dynamics amended to take account of the magnetic field. This project will start with an introduction to the MHD equations, considering in detail the effect of the magnetic field. It will then go on to look at how these equations can explain a number of key features of the solar magnetic field. For example,

(i) how the field is continually regenerated within the Sun, against its natural tendency to decay (the solar dynamo problem);

(ii) how the field escapes from the interior, eventually to emerge at the surface as sunspots;

(iii) how magnetic fields can become unstable, as occurs dramatically in a solar flare.

Some knowledge of fluid dynamics (MATH2620, for example) is necessary to undetake this project; a reasonable understanding of one of the vector calculus courses is also necessary. It is not necessary to have studied any astronomy or electromagnetism.