Karl-Schwarzschild Lecture

Cosmic magnetic fields

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Magnetic fields are omnipresent in the Universe. We know of records by the Chinese or the Greeks in which magnetic effects were discussed. Certainly the navigation of ships in the middle ages depended on the use of the compass. The first experiments with magnets were described by Gilbert in 1600. Johannes Keppler speculated on the magnetic effect that was forcing the movement of the planets. This suggestion was negated by Isaac Newton who developed the gravitational theory. Finally the electromagnetic theory was developed by James Clerk Maxwell that described the action of electric current and magnetic field. Practical devices as the dynamo or electric motor came from this theory.

Peter Zeeman made measurement of magnetic field at a distance by observing the splitting of line emission in a magnetic field. Very soon after the Zeeman Effect was postulated the first measurements of magnetic fields were made by Hale in the Sun in 1908. The discovery of cosmic radio waves by Karl Jansky in 1932 added another method of measuring magnetic fields the cosmic radio waves were due to a non-thermal emission process the action of relativistic particles in magnetic fields. Since this synchrotron emission is polarized the study of the polarization of the cosmic radio waves allows the determination of magnetic fields.

I have become involved in studies of polarization of Galactic radio waves during my PhD studies in Cambridge 1960-1963. The first radio detections of magnetic field in a cosmic object, the Crab nebula, were made in 1957. In the summer of 1962 the first unambiguous detection of the polarization of Galactic radio waves and hence of magnetic fields in the Milky Way were added. The whole year 1962 may be termed a magnetic year. Polarization was detected in radio galaxies, and in supernova remnants. In 1968 pulsars were discovered and showed unusual polarization properties. The elusive radio Zeeman Effect was finally detected in 1968 using the HI line emission in selected Galactic regions. The studies of magnetic fields have started in 1962 and go on to the present day. The 100m radio telescope in Effelsberg played a significant role in this research field.