MAGNETISM IN THE UNIVERSE

A.P. Guimarães. Centro Brasileiro de Pesquisas Físicas, R. Xavier Sigaud 150, 22290-180 Rio de Janeiro, Brazil E-mail: apguima@cbpf.br.

Magnus magnes ipse est globus terrestris – "the Earth globe itself is a great magnet", wrote William Gilbert in 1600, in the *De Magnete*. This discovery is a remarkable advance in the knowledge about the Earth and in fact it represents one of the earliest recognitions of a global property of our planet, the second after the admission of its roundness. In the 400 years since the publication of the *De Magnete*, magnetism has been shown to be a widely prevalent natural phenomenon that acts in a vast range of scales, from the microscopic world to the distant galaxies.

The understanding of the magnetism of matter was made possible with the discovery of the relationship between electricity and magnetic phenomena in the XIX century, together with the introduction of Quantum Mechanics in the first decades of the XX century. The magnetism of our planet was found to be different from that of magnetite, with the proposal in 1919 of the dynamo model by the Irish physicist Joseph Larmor. This mechanism, active in many planets of the solar system, as well as in the Sun, is essentially based on the effect of electric currents circulating in the core of the astronomical body.

The Earth magnetism has undergone important modifications along the life of the planet, most significantly polarity reversals every few hundred thousand years. The magnetic activity of our planet has a wide range of effects, from the trapping of charged particles emitted by the Sun to the influence on the habits of uncountable living creatures that have evolved forms of sensing it.

The next source of magnetic activity, in an ascending astronomical scale is the Sun, where the same dynamo effect actuates. The cycle of magnetic activity of the Sun is correlated with the cycle of sunspots; every 11 years, a new cycle begins, and this is accompanied by a reversal of overall magnetic polarity. Around the sunspots, intense magnetic fields are observed.

Many other stars are known to be surrounded by magnetic fields. Neutron stars are the most remarkable objects from the magnetic point of view, since a class of these stars exhibit the largest magnetic fields found anywhere in the universe. These are the soft gamma ray repeaters (SGR), or magnetars, with fields 10^{15} stronger than those found on the Earth surface.

On the grand scale of the galaxies, magnetic fields have been detected and studied, with lines of fields that often parallel the arms in spiral galaxies. These are much weaker fields than those found on the surface of our planet, but which may have played a role in the shaping of the galaxies [1].

Magnetic fields may still hold the clue for important unanswered questions that refer to the large scale of the universe, such as the origin of high energy cosmic rays.

The study of magnetism and magnetic properties of materials has grown with a very rapid pace in the last decades, to a large extent stimulated by the development of magnetic recording media, a vital component of every computer. Magnetic recording density has doubled every two years since the 1950s!

Originally shrouded with mystery in the first days of civilization, magnetism still retains its appeal to our days, as a remarkable and fascinating natural phenomenon.

[1] Widrow, L.W. 2002. *Reviews of Modern Physics* 74: 775-823.