Electromagnetic waves

Lecture 9

Directional Magnetic Field

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9.1Introduction

Magnetic phenomena were first observed at least 2500 years ago in fragments of magnetized iron ore found near the ancient city of Magnesia (now Manisa, in western Turkey). These fragments were examples of what are now called permanent magnets; you probably have several permanent magnets on your refrigerator. Permanent magnets were found to exert forces on each other as well as on pieces of iron that were not magnetized. It was discovered that when an iron rod is brought in contact with a natural magnet, the rod also becomes magnetized. When such a rod is floated on water or suspended by a string from its center, it tends to line itself up in a north-south direction. The needle of an ordinary compass is just such a piece of magnetized iron. Before the relationship of magnetic interactions to moving charges was understood, the interactions of permanent magnets and compass needles were described in terms of magnetic poles. If a bar-shaped permanent magnet, or bar magnet, is free to rotate, one end points north. This end is called a north pole or N pole; the other end is a south pole or S pole. Opposite poles attract each other, and like poles repel each other Fig.9.1 Opposite poles attract each other, and like poles repel each other. An object that contains iron but is not itself magnetized (that is, it shows no tendency to point north or south) is attracted by either pole of a permanent magnet.

By analogy to electric interactions, we describe the interactions by saying that a bar magnet sets up a magnetic field in the space around it and a second body responds to that field. A compass needle tends to align with the magnetic field at the needle's position. The earth itself is a magnet. Its north geographic pole is close to a magnetic south pole, which is why the north pole of a compass needle points north. The earth's magnetic axis is not quite parallel to its geographic axis (the axis of rotation), so a compass reading deviates somewhat from geographic north. This deviation, which varies with location, is called magnetic declination or magnetic variation. Also,the magnetic field is not horizontal at most points on the earth's surface; its angle up or down is called magnetic inclination. At the magnetic poles the magnetic field is vertical see Fig. 9.2.