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Crucial role of the magnetic field in the evolution of life

U R RAO
ISRO Satellite Centre, Bangalore 560 058, India

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Abstract. The formation of a steady ozone layer in the earth's atmosphere is the most significant event in the evolutionary cycle of the earth which, in turn, has been responsible for the development of life with an oxygen metabolism. In addition to protecting biological life from exposure to ultraviolet radiation the ozone layer has also been responsible for maintaining the water and oxygen balance in the atmosphere. It is argued that the magnetic field of the earth is really responsible for the formation of this steady ozone layer in the earth's atmosphere. Because of the earth's magnetic field and associated trapped charge particle belts and the magnetosphere, the earth's atmosphere does not directly interact with the interplanetary space. Without such a shielding, the free oxygen atoms could have been depleted considerably causing a severe depletion in the ozone concentration to start with. The impact of charged particles from galactic and solar cosmic rays over the entire earth's atmosphere and the consequent production of NO_x would have given rise to a major ozone sink, if earth were devoid of a magnetic field. The net result would have been the absence of a steady ozone layer and the absence of life with an oxygen metabolism, as in the case of the atmospheres of Venus and Mars, if the earth did not have a magnetic field.

Keywords. Ozone; geomagnetic field; nitric oxide; trapped particles; ozone sink.

1. Introduction

The large amount of information gathered during the last two decades through *in situ* explorations and laboratory experiments now provides us an unique opportunity to reexamine our fundamental ideas and assess their role in the evolution of biological life, as it exists today on the earth. The condensation of solar nebula and the formation of the solar system, about 5 billion years ago, the planetary formation as we know today and the virtual loss of hydrogen and helium from the inner or terrestrial planets, through molecular escape as also due to the sweeping action of solar wind, are fairly well understood. From the observed physical properties of planets such as density, atmospheric pressure, temperature, chemical composition and surface gravity, it is clear that the solar system of planets can be classified under two broad headings namely (i) high density terrestrial planets with a heavy core like Mercury, Venus, Earth and Mars and (ii) lighter gaseous outer planets such as Jupiter, Saturn and other outer planets.

An examination of the atmosphere of outer planets indicates that they have primarily a non-oxidising, primordial atmosphere with a fluidic surface unlike all the inner planets which possess an oxidising secondary atmosphere with a solid surface, evolved through the venting of trapped gases from within the planet. It is, therefore, clear that only the inner planets can, if at all, sustain life with an oxygen metabolism.