DOES MARS HAVE AN ACTIVE MAGNETIC DYNAMO? C.T. Russell, Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California, 90024.

Mars spins at a rate very similar to the earth and much faster than Mercury spins. Its size is intermediate between Mercury and the earth. Thus, if dynamo action depended only on spin rate and core size then one might expect Mars to have a magnetic moment intermediate between that of the Earth and Mercury. However, the reported moment\textsuperscript{1} is much less than that of the Earth and less than that of even Mercury\textsuperscript{2,3}. At a very minimum this fact implies that the interior properties of Mars are not intermediate between those of Mercury and the earth. The most attractive explanation for the weakness of the planetary field is that the motion of the conductive material in the interior of Mars is insufficient to sustain a planetary dynamo. However, if this is indeed the case, one is left with the problem of explaining the observed moment.

Magnetometers have never been placed on the Martian surface. All measurements have been made from orbit at altitudes above 1000 km. Thus, the calculation of the Martian moment rests on the identification of a Martian magnetosphere and the deflection of the solar wind flow about the planet. Possible sources of such a Martian magnetosphere include not just an intrinsic planetary field such as caused by a planetary dynamo or a permanently magnetized crust, but also currents driven in the ionosphere by the solar wind motional electric field and the draping and compression of interplanetary magnetic field lines around the obstacle as occurs in the earth’s magnetosheath.

Dolginov maintains that his observations can be explained only in terms of an intrinsic planetary field\textsuperscript{4,5}. His arguments are based on the position of the bow shock of the planet and the inferred size of the obstacle, the location of boundaries interpreted as magnetopause crossings, and the observation of a Martian magnetotail, independent of the component of the interplanetary magnetic field parallel to the solar wind flow.

We have examined all the Mars data published by Dolginov and colleagues. According to our analysis bow shock positions are consistent with the obstacle to the solar wind flow being simply the planetary ionosphere. No larger obstacle is required by the data. We conclude that none of the boundaries identified as magnetopause crossings have characteristics of magnetopause crossings as observed at earth and Venus. The component of the interplanetary magnetic field which determines the polarity of the field in the Martian wake is the component perpendicular to the solar wind flow, not the component parallel. In all of Dolginov’s examples, the magnetic field has a strong southward component even when the component parallel to the solar wind flow reverses.

In summary, we feel there is no clear evidence for an intrinsic field at Mars. The moment is probably less than 2x10\textsuperscript{21} Gauss-cm\textsuperscript{3}. In contrast, Venus, whose rotation rate is about 4x10\textsuperscript{-3} that of the earth and whose radius is similar to that of the earth has a moment of 0.3 to 0.8x10\textsuperscript{-3} of the terrestrial moment\textsuperscript{6,7}. Thus Mars with a rotation rate like that of the earth, a radius one half the terrestrial value, and a moment \textlesssim 2x10\textsuperscript{-5} of the moment of the earth seems to have no present day internal dynamo action. It is most probable that Mars’ magnetic fields more resemble lunar magnetic fields which are derived from locally coherent regions of crustal magnetization than the magnetic fields of the other terrestrial planets.
Martian Dynamo?

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REFERENCES