Magnetic Mars Dust Removal Technology
Francisco J. Arias¹ and Salvador De Las Heras¹
¹Department of Fluid Mechanics, University of Catalonia,
ESEIAAT C/ Colom 11, 08222 Barcelona, Spain
francisco.javier.arias@upc.edu
salvador.delasheras@upc.edu

Introduction:
It is known that Mars atmosphere contains a large load of suspended dust. Saltation process or the settlement of atmospheric dust onto the surface of solar arrays can affect the utility on solar power on any Mars mission, and specially for long term operation. This can be a special issue for the case of a future 6-months Sample Fetching Rover (SFR) mission where the current baseline architecture contemplates the use of solar array instead. For this relatively 6-months long operation dust storms can jeopardize the entire mission, not only in the supply of energy for locomotion but for the communication with the Mars Ascent Vehicle (MAV). For instances, it was early calculated that the power loss of solar array caused by settled dust for mission on Mars can be around 52.2 % to 89 %, [1]. Dust is expected to be adhered to the array by Van der Waals adhesive forces which can be very strong for the dust particles sizes. Today, available dust-removal techniques can be classified into four categories, [2], namely: -natural, -mechanical, -electromechanical, and -electrostatic. Natural dust removal relies in the possible capability of surface martian wind for cleaning the solar array which seems not to be applicable for horizontal arrays at locations with wind conditions similar to those found at the Viking landing site. Mechanical-removal is based in the use of mechanical wiping, blowing, or removable covers, however, the constraint in weight for a SFR mission makes this a not very reasonable approach. Electromechanical-removal comprises shaking the array, or using sound to break dust adhesion, however, besides to have the problem of weight, also it would be necessary another supplementary system to carry the dust away after adhesion is broken. Finally, electrical-removal is based in inducing electrostatic forces. For this last method, if the array surface is charged and conductive enough, dust particles will accumulate a charge the same as the array, and then repelled from the array. Nevertheless, for this method -which so far has been stated as the best approach, they also, as in the electromechanical removal, will require and supplementary system, wind or tilting the array to carry the dust away.

In this work we propose a new approach as a result of the recent information recorded from the last years on Mars. This approach is as follows: From the recorded data from recent Mars missions, there are substantial evidence that the dust of Mars is strongly magnetic. In fact, almost all dust particles in the Martian atmosphere are magnetic, according to new data obtained by NASA’s Mars Exploration Rover Spirit containing mostly the strong magnetic mineral magnetite (Fe₃O₄). If so, the magnetic properties of the martian dust can be harnessed as a new removal technique. It is well known that a particle with magnetic properties (magnetic dipole, as is the case for magnetite Fe₃O₄) when is under the action of a magnetic field gradient, the magnetic dipoles are attracted/repelled into regions of higher magnetic field, in other words there will be a net magnetic force acting on the magnetic particle. Now it is straightforward to envisage the significance of this phenomena for Mars-dust removal technology. By generating a localized magnetic field, it could be possible to vertically push dust particles away from, say, the solar array. The principle behind of this technique which is conspicuous by its simplicity and robustness, also, deserves special consideration because the easiness for application. In fact, a simple, almost weightless hollow tube wrapped by copper wire (a sort of solenoid) will be enough, or the use of a permanent magnet. Besides of dust magnetic cleaning of solar arrays, or the samples, also, the same principle can be used experimentally to know the fraction of dust which is actually magnetized.

References: