Dark Halo: Evidence for Atmosphere-Ground Interaction at Martian Volcanoes

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On the planets having atmosphere such as Mars, there are various types of interactions between the atmosphere and the ground surface. Such interactions leave observable changes in the surface patterns. Polar caps and aeolian features are typical examples. Here we report a new kind of time-variable surface pattern called Dark Halo near the top of high altitude volcanoes in Tharsis region.

Recent continual and high-resolution imaging observations have revealed remarkable features of Dark Halo:
1. Dark Halo is composed of assemblage of dark spire-shaped streaks, hereafter we call Spire Streaks.
2. Each streak starts from a point-like very narrow region.
3. In most cases, no topographical obstacle can be identified at the initiation point.
4. Each Spire Streak starts at high position and increases its width downward. Combined with crater-attached wind streaks in the same region, the spire streaks are aligned parallel to the dominant wind and the wind-ward is at the narrow point.
5. Dark Halo and Spire Streak universally exist near the top of high mountains (Olympus, Elysium, Pavonis and Ascraeus) although the actual heights are not uniform.
6. Dark Halo shows temporal changes in its pattern. There are drastic changes in the pattern between before and after the global dust storm 2001. In this case, deposition of fine dust could be responsible for erasing the previously existing Dark Halo and Spire Streaks. The changes of the pattern occured only a few times between 1977 and 2007.
7. The nighttime temperature and pressure at Dark Halo is near the phase boundary of carbon dioxide.
8. Spire Streaks can pass over topographic obstacles.

These features are not compatible with existing models of aeolian streaks.

Data from visible imagers, imaging spectrometers, a laser altimeter and a numerical modeling are investigated to understand the formation process of Spire Streak and Dark Halo.

The favored model which explains the above-mentioned observation is either 1) erosion of fine dust by strong slope wind or 2) deposition of wind-blown material emanated from very narrow region. Both origins are completely new kind of wind-surface interactions that have not ever discovered. Dark Halo might reflect past extreme circumstances at Martian volcanoes, and could be used as an indicator of the surface environment on Mars.