BRIGHT AND DARK FANS IN THE MARS CRYPTIC REGION – EVIDENCE FOR COLD CO_2 GAS JETS.

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Introduction: Gas jets produced on icy surfaces have been observed throughout the solar system – ranging from the N_2 jets of Triton [1,2] to the plumes of Enceladus' south polar region [3] and to a region of Mars southern seasonal cap informally referred to as the "cryptic region" [4,5].

For over a decade, observations of the retreat of the Mars southern seasonal cap have revealed the presence of exotic processes within the "cryptic region." The appearance of dark spots, fans, blotches, and halos have been the focus of intensive scientific discussion since they were first observed by the Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) [6]. Further observations in the Mars Odyssey (ODY) Thermal Emission Imaging System (THEMIS) showed the dark features remain cold throughout the early-to-mid spring, suggesting that these features were either CO_2 ice or in thermal contact with CO_2 ice [7].

The CO_2 gas-jet model was first proposed by Kieffer [8] in 2000, and later expanded by Piqueux et al. [9] and Kieffer [10]. Based on Near Infrared (NIR) observations from the Mars Reconnaissance Orbiter (MRO) Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), Titus et al. proposed a modified jet model presented here [11,12] (Figure 1).

We present evidence that many of these features are the result of cold jets which are occurring within the cryptic region and that the gas erupted from these jets undergoes adiabatic (expansion) cooling, thus producing CO_2 frost that is then blown downwind, forming bright fans. The bright fans appear to be devoid of H_2O ice, thus further supporting the hypothesis that they are formed from the downwind settling of CO_2 frost. In some areas, the bright fans share a common vertex with dark fans, while in other areas bright fan-like deposits occur without the strong presence of dark fans.

When NIR spectra from the translucent ice is compared to the model spectra, we find that the translucent ice is composed of mainly CO_2 ice with approximately 0.1% water ice with a grain size of ~250 μm and 0.001% dust with a grain size of ~3 μm. These fractional abundances and grain sizes of H_2O ice and dust are what one might expect from the condensation of the atmosphere onto the seasonal cap during the fall and winter seasons. The size of the dust is consistent with atmospheric dust. The H_2O abundance is consistent with the mean amount of H_2O vapor typically found in the Mars atmosphere. While the spectra from the translucent ice can be compared directly to model spectra of uniform heterogeneous material, the fan spectra are best compared to a ratio of the fan spectra and the ice spectra. This is because the fan is a thin, partially translucent layer that lies on top of the translucent ice. The bright fan spectra are consistent with the spectral ratio for a fan that has a CO_2 column density of $0.2 kg/m^2$ and is composed of pure CO_2 with a grain size of r=362 μm. This grain size is consistent with calculations by Kieffer [10] that show fall times for the particles in the jets. CO_2 and dust grains that are smaller would just be blown downwind and never settle out. The ratio of a spectrum from a dark fan divided by a spectrum from the translucent ice is consistent with the model of the fan as a thin layer of dust and snow on top of translucent ice.

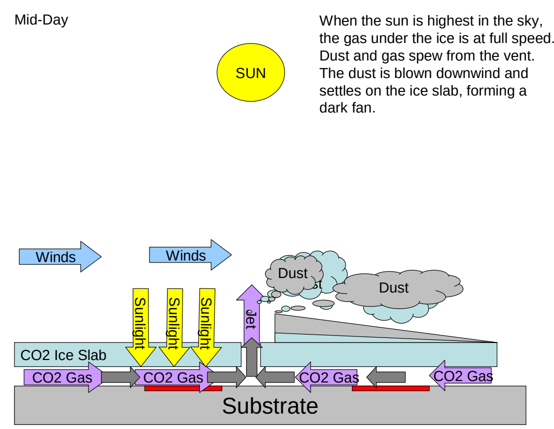

Figure 1: Graphic of the Modified Jet Model.

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