



**The properties of Martian high altitude clouds:  
An investigation based on images captured from India's first Mars mission**

Jyotirmoy Kalita <sup>1\*</sup>, Barin Kumar De <sup>1</sup>, Manoj Kumar Mishra <sup>2</sup> and Anirban Guha <sup>1</sup>

(1) Department of Physics, Tripura University, Suryamaninagar, Tripura - 799022, India

E-mail: [anirban1001@yahoo.com](mailto:anirban1001@yahoo.com),

(2) Space Application Centre, Indian Space Research Organization, Ahmedabad-380053, India

Mars Colour Camera (MCC) is a medium resolution camera onboard India's first Mars Orbiter Mission (MOM). MCC captured 827 images of Mars from varying distances in the first two years of operation in 2014 and 2015 that includes more than 20 limb viewing images. In our analysis, we considered 10 images of high altitude limb-viewing clouds. Through image processing techniques, we computed the projected heights of the clouds. We developed codes for the calculation of Top of the Atmosphere (TOA) reflectance and  $\alpha$  value for the high altitude limb clouds visible from MCC. We furnish below the key results highlighting the main findings from the analyzed results. Using spatial pixel resolution counts, projected heights for the limb viewing images is estimated around 33-93 km above the surface of the Mars. After the zenith angle and lens correction, the projected heights become 43 km to 123 km. Horizontal extension of the clouds in the Martian limb is found to be around 400km to 1300 km. Top of the Atmosphere (TOA) reflectance value is computed to be 0.18 for red wavelength and 0.13 for blue wavelength. This indicates a presence of hexagonal H<sub>2</sub>O ice crystal as well as CO<sub>2</sub> ice crystal in the Martian clouds. Angstrom exponent ( $\alpha$ ) value varies from 0.8 to 1.88 within the cloudy region of the atmosphere that may indicate the presence of coarse mode as well as fine mode particle. C/2013 A1, a cometary object passed through the Martian atmosphere on 14<sup>th</sup> October 2014 may indicate an extra-territorial origin of the dust clouds in the Martian atmosphere. Formation of clouds at Solar longitude L<sub>s</sub>=200° to L<sub>s</sub>= 251° indicate an evidence that the origin of the cloud may also be dust storm in the Martian atmosphere or solar wind. We need more evidence to confirm the hypothesis for the formation of the high altitude clouds in the Martian atmosphere.