THE SPECTRAL FEATURES OF POTENTIAL LIFE MARKERS ON MARS BY MULTIPLE SPECTRAL DETECTION. Wang Liu[1], Zhongchen Wu[1,*], Wenxi Chen[1], Guobin Jin[1], Li Zhang[2]. [1]Shandong Provincial Key Laboratory of Optical Astronomy and Solar-Terrestrial Environment, Institute of Space Sciences, Shandong University, Weihai, Shandong, 264209, China (z.c.wu@sdu.edu.cn); [2]School of Mechanical, Electrical and Information Engineering, Shandong University, Weihai 264209, China.

Introduction: For more than half a century, more attentions were paid to the exploration of Mars and its biological information. Mars is the fourth earth-like planet in our solar system. It has atmosphere, solid crust, water-ice and similar seasons/climates with Earth. Mars has all bioelements[1] and also meets habitability conditions for biogenesis earlier than the Earth because of faster thermal dissipation after it formed due to its small mass/volume[2]. Exploration of Martian surface and the biological information on it is an international prosperous research area.

From ViKing in 1976 to today's Perseverance in the Jezero Crater, searching for life is the highest priority task and some suspected materials were also detected[3, 4]. In addition, the high abundance of iron oxide, oxychloride on Mars indicates that the Martian environment is highly oxidizing, and the high dose of UV radiation also affects the preservation of organic matter on Mars[5, 6]. Organic matters, if those materials ever had been present on Mars, may have undergone some kind of degradation[7]. Therefore, detection of organics under those oxidation conditions and investigating the preservation/degradation mechanism are of equal importance for Mars life exploration. Herein, a new method to search for life signals on Mars using multiple spectral methods such as LIBS, Raman, FTIR were proposed and preliminary results were reported.

Samples and Methods: We present a spectral study of some representative simulated Martian materials(i.e. MGS-1 Simulated Martian soil, montmorillonite, gypsum and carbonate), potential organic matter (Chitin, chitosan, cellulose, D-alanine and glycine) and their mixtures. Simulated Martian material represents the geological environment of Mars[4, 8, 9]. Three natural organic compounds and two amino acids are selected as biomarkers of the basic building blocks of proteins[10, 11]. LIBS, Raman and FTIR were used to detect the target pure components as well as mixtures with their associated minerals. And their spectral features were also well analyzed.

Results: For FTIR spectra, chitin, chitosan, and cellulose showed remarkable and non-overlapping absorption peaks which were different from their associated Martian minerals. For example, as shown in Fig.1 and Fig.2, Natural organic polymer materials showed absorption peaks at ~2900 cm^{-1}, while amino acids showed absorption peaks at ~3100 cm^{-1}. And all those peaks belong to C-H stretching vibrations mode [12], which could be used to identify organic matters from Martian minerals.

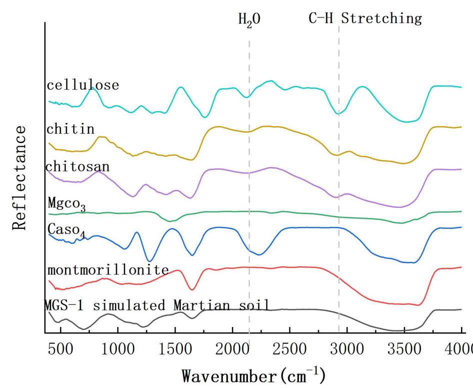

Figure1: FTIR Diffuse reflection of some natural organic polymer materials (chitin, chitosan, cellulose) and Martian minerals (Montmorillonite, MGS-1 Simulated Martian soil, $CaSO_4$ and $MgCO_3$).

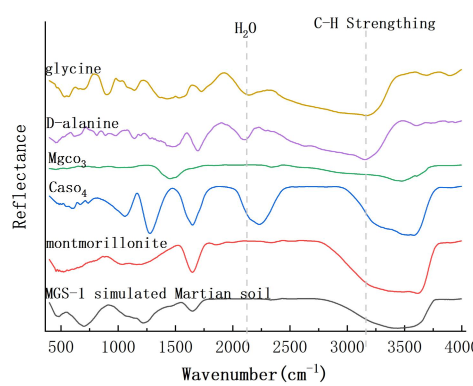

Figure2: FTIR Diffuse reflection of other natural organic polymer materials (D-alanine and glycine) and Martian minerals (Montmorillonite, MGS-1 Simulated Martian soil, CaSO4 and MgCO3).

Raman Spectroscopy (excitation wavelength: 532nm) was also used to characterize the spectral features of those samples. However, almost no Raman spectra were recorded on chitin, chitosan, cellulose and montmorillonite except of amino acids because of serious fluorescence interferences[13].

For LIBS, the molecular peaks of C-N at 385, 386, 387, 388 nm for all organic substances were clearly identified (as shown in the Fig.3)[14].

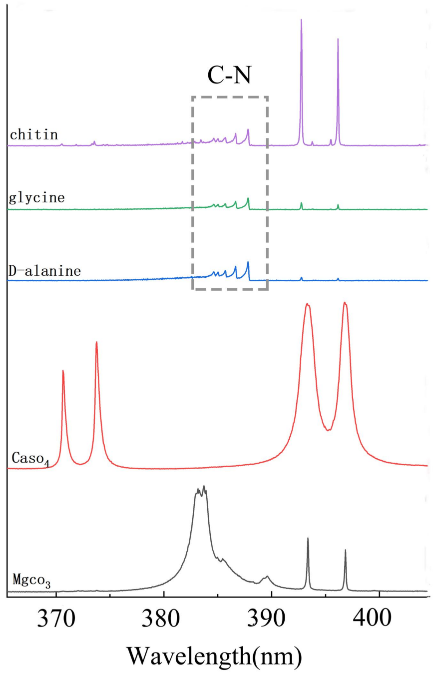

Figure3: LIBS spectra of Natural organic polymer material (chitin), Martian minerals (CaSO4, MgCO3) and amino acids (D-alanine and glycine).

Discussion: In this work, the spectral feature of the potential organic matter on Mars and their associated minerals were characterized by FTIR, Raman and LIBS. The target organic matter has some remarkable spectral features different from their associated minerals which provides an important clue for Martian life living matter/fossil exploration. In order to get better quality of Raman data, a long-wavelength lasers (1064nm) was needed for Raman excitation in future work. And LOD (limit of detection) of the target organic matters were also needed to be detected by the above multiple spectroscopic technologies.

Recent studies have shown that the electrostatic discharge (ESD) induced by Martian dust activities modify the structure and chemistry of Martian salts[15]. The degradation of ESD and UV photolysis of those organic matter should be well investigated as well as their preservation conditions in near future.

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