ROADMAP - FROM LAB TO SPACE: EXPERIMENTAL SCATTERING MATRICES OF MARTIAN DUST ANALOGUES.

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We present experimental scattering matrix elements as functions of the scattering angle of three Martian dust analogue samples (JSC Mars 1, MMS2, and MGS1). The measurements are performed at the IAA Cosmic Dust Laboratory at a wavelength of 640 nm.

Introduction

Dust aerosol particles scatter and absorb solar radiation playing a key role in determining the thermal structure of Martian atmosphere. In the context of the EU funded RoadMap project (http://roadmap.aeronomie.be) we aim to generate an optically relevant Mars dust analogue as far as size and mineralogy is concerned. The experimental study is motivated by the lack of satisfactory modelling approaches traditionally used to mimic the role of mineral dust in the Martian atmosphere. A major advantage of experimental measurements at visible wavelengths is that we can deal with real ensembles of dust particles covering relatively broad size ranges (including the resonance region). However, a systematic study of the impact of different physical properties on scattering of the sample under study remains extremely challenging due to the difficulty in finding the appropriate samples. In RoadMap we use processing routines imported from the field of functional, nano- and microceramics research for the synthesis of the dust analogues with tailored properties.

Martian Analogue Samples

We are studying three Martian dust analogue samples: JSC Mars 1 (Johnson Space Center regolith simulant [Allen (1998)]; MMS-2 (Enhanced Mojave Mars 2 Simulant); and MGS-1 (Mars Global Simulant) [Cannon et al. 2019]. Table 1 presents the mineral description for the three analogue samples. Retrieved optical constants in the UV-vis-NIR are presented by Martikainen et al. This conference.

The bulk samples have been milled, sieved, and subsequently dispersed for producing well-defined narrow size distributions spanning over a broad range in the scattering size parameter domain, namely: $r_{eff} \sim 0.1\mu m; r_{eff} \sim 1\mu m; r_{eff} \sim 10-20\mu m$. In this way we will be able to disentangle size and composition effects on the scattering behaviour of our dust analogue samples.

Table 1: Bulk major element chemistry for the JSC Mars-1 (JSC1), Enhanced Mojave Mars 2 (MMS-2), and Mars Global (MGS-1) simulants.

Oxide	JSC1	MMS-2	MGS-1
SiO_2	43.5	43.8	50.8
TiO_2	3.8	0.83	0.3
Al_2O_3	23.3	13.07	8.9
Cr_2O_3	-	0.04	0.1
Fe_2O_3	15.6	18.37	-
FeO	-	-	-
MnO	0.3	0.13	0.1
CaO	6.2	7.98	3.7
MgO	3.4	6.66	16.7
Na_2O	2.4	2.51	3.4
K_2O	0.6	0.37	0.3
P_2O_5	0.9	0.13	0.4
SO_3	-	6.11	2.1
Cl	-	-	0.55
SUM	100	100	100

Experimental Scattering Matrices

The scattering matrices of our samples are measured at the IAA COsmic DUst LABoratory (CODULAB) located at the Instituto de Astrofísica de Andalucía, Granada, Spain. For a detailed description of the experimental apparatus, calibration process, and data acquisition we refer to [Muñoz et al. (2010)]. As an example in Fig.1 we present the measured scattering matrix for the MMS2 at 640 nm.

All matrix elements (except F_{11} itself) are normalized to F_{11}, that is, we consider F_{ij}/F_{11}, with i, j=1 to 4 with the exception of $i = j$ =1. The values of $F_{11}(\theta)$ are normalized so that they are equal to 1 at θ=30°. The function $F_{11}(\theta)$, normalized in this way, is called the phase function or scattering function. As shown in Fig.1, the experimental phase function presents the typical behavior for irregular aerosols i.e. Strong forward peak and flat dependence on the scattering angle at side-

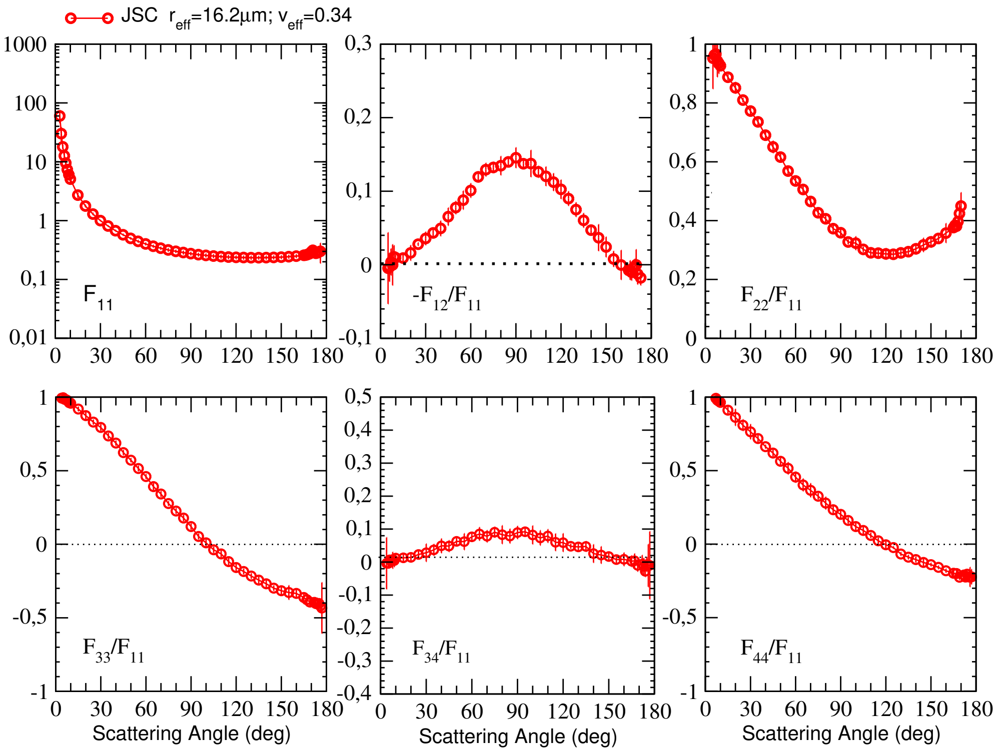

Figure 1: Measured scattering matrix elements for the JSC sample ($r_{eff} = 16.2\mu m : v_{eff} = 0.34\mu m$).

and back-ward directions.

The experimental scattering matrices will be used to check the validity of state-of-the-art numerical techniques based on simplified model particles to reproduce the scattering behaviour of realistic poly-disperse irregular particles. We will present preliminary results based on tri-axial ellipsoids and hexahedral particles.

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