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Analysis of Q-type Near-Earth Asteroid Spectra with Modified Gaussian Models† ⋆

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Abstract Using the Modified Gaussian Model (MGM) developed by Sunshine et al., we extract the mineralogical information from the reflection spectra of eight Q-type near-Earth asteroids, and obtain their surface composition of orthopyroxene and clinopyroxene. We further get a compositional proportion of each asteroid: the abundance of clinopyroxene is about 70% on the surfaces of the asteroids 5143, 7341, 66146, and 162058, and it is about 60% on the surfaces of the asteroids 1862, 4688, and 5660, but only 43% on the surface of the asteroid 3753. Then we analyse the reason for the apparently low abundance of clinopyroxene on the surface of the asteroid 3753. The level of metamorphism experienced by an asteroid increases with the decreasing distance from the Sun, so the asteroid 3753 is highly metamorphosed, and the abundance of clinopyroxene is low.

Key words astrochemistry, asteroids: individual: 3753, planets and satellites: components, methods: data analysis

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1. INTRODUCTION

Asteroids are small celestial bodies which revolve around the Sun on their elliptical orbits, most of them are distributed between the orbits of the Mars and Jupiter, they are the remains after the formation of the early solar system, which contain a large amount of primitive information of the early solar system, the study of asteroids has important significance for understanding the origin and evolution of the solar system. There are a huge number of asteroids in the solar system, the total number is estimated in the order of several millions, sofar about 700 thousands have been discovered. According to the dynamical properties of the asteroidal orbits in the inner solar system, the asteroids can be divided into three major types: main-belt asteroids, near-Earth asteroids, and Trojan asteroids. In which the orbits of near-Earth asteroids are close to the Earth orbit, and even able to cross over the Earth orbit, they are the potential threats to the safety of terrestrial space, hence, in recent years the study of near-Earth asteroids has been widely concerned. We select eight Q-type near-Earth asteroids to study the composition of their surface minerals, which may provide a reference for studying further the origin and evolution of near-Earth asteroids.

Many studies classify the asteroids with similar orbital semi-major axes, orbital eccentricities, and inclinations as an asteroid family[1], and believe that the asteroids in one family form by the collision of one and the same mother body. Because that in the long-term evolution of the solar system, the orbits of asteroids will be affected by various factors, so that the asteroids with similar orbital elements may not originate from the same mother body, namely the membership judgement of an asteroid family has a certain uncertainty. According to the features of reflection spectra of asteroids, Wood et al.[2], Chapman et al.[3], and Zellner [4] classified the asteroids into the dark carbonaceous asteroid and bright stony asteroid two types, and Chapman et al.[5] divided further the asteroids into the C, S, and U three types: C represents the dark carbonaceous type, S represents the silicic type, U represents the asteroids of uncertain type. The up-to-date spectroscopic classification of asteroids is that proposed by DeMeo et al.[6−8], which classifies the asteroids into the S, C, and X three major types and 5 other types, and each major type is further divided into a few subtypes, totally 24 types. As the reflection spectra can reflect the composition of asteroid surface materials, the study of spectroscopic classification may supply some supplementary basis for the membership judgement of asteroid families.

In the spectroscopic classification of asteroids, different types of asteroids correspond to different compositions of their surface minerals, implying their different experiences in the evolution of the solar system. With the development of high-resolution spectroscopic technique, a large number of high-resolution spectral data of asteroids can be obtained, using these spectral data to analyze accurately the composition of asteroid's surface minerals is an important subject in the study of asteroids. To analyze the reflection spectra for studying the composition of surface minerals plays an important role in the lunar and planetary explorations, but some difficulties exist in the study of surface mineral compositions of