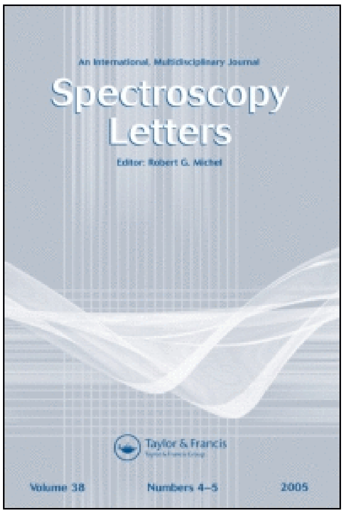

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Nayanjyoti Dehingia[a]; Gaurangadhar Baruah[a]
[a] Department of Physics, Dibrugarh University, Dibrugarh, India

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Extended Red Emission in Mahadevpur (Namsai) Meteorite

Nayanjyoti Dehingia and Gaurangadhar Baruah
Department of Physics, Dibrugarh University, Dibrugarh, India

ABSTRACT Laser-induced fluorescence spectrum of Mahadevpur (near Namsai) meteorite of type H4/5 ordinary chondrite was excited with the help of a 25-mW green diode-pumped solid-state laser (532 nm), and a diffuse spectrum was photographed on a glass spectrograph in the wavelength range of 5400–6500 Å. The band system is attributed to silicate (olivine), a major component of the meteorite. A comparison of the emission system with that of Dergaon meteorite of type H5 ordinary chondrite was made.

KEYWORDS LIF, Mahadevpur meteorite, red emission

INTRODUCTION

The ubiquity of dust (interstellar, circumstellar, interplanetary, cometary and asteroidal) is an indication of its importance in a variety of astrophysical environments. Over the past decade, there has been increasing recognition that astrophysical dust is not simply homogeneous mass of amorphous materials, but that it frequently occurs as crystalline silicates. The most abundant minerals recognized are the Mg–Fe silicates, olivine and pyroxene.[1] These identifications have been based on the interpretation of strong features in the Fourier transform infrared (FTIR) spectra of astronomical dust, and IR spectroscopy is now a powerful tool that relates astronomical data to laboratory-based studies of dust.[2] Mid-IR (between 10 μm and 20 μm) spectroscopy of a variety of galactic environments reveals smooth emission and absorption bands that have been associated with Si-O stretching and bending modes.[3] Bowey and Adamson matched the gross properties of the astronomical profiles (the width and the wavelength of the peak) with a mixture of crystalline silicates (the spectral features of which are narrow and highly structured) with a relatively small component of amorphous silicates. By this analysis, the breadth of the 10-μm features in the circumstellar disks surrounding young stars could be reproduced by a mixture of crystalline pyroxenes with varying stoichiometries (80% by mass) and amorphous silicates (20%). Such an explanation may be more consistent with the interpretations of the far infrared spectra of young and old stars with circumstellar dust shells and disks obtained with the infrared space observatory. The narrow spectral emission features indicate the presence of crystalline silicates. Many previous investigations have used terrestrial minerals and artificial glasses for calibration and spectral matching with

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Address correspondence to Gaurangadhar Baruah, Department of Physics, Dibrugarh University, Dibrugarh – 786004, India. E-mail: gdbaruah@rediffmail.com

astronomical data. Olivine is one of the most common of meteoritic silicates, and the olivine occurs in several locations within primitive meteorites: in chondrites, in fine-grained interchondrule matrix, in high-temperature aggregate, and as isolated grains. In this connection, it is worthwhile to refer to the phenomenon of dust luminescence or the Extended Red Emission (ERE). In 1980, Schmidt, Cohen, and Margon detected in the Red Rectangle a far-red continuum emission in excess of what would be expected from simple scattering of starlight by interstellar dust. The Red Rectangle is a highly symmetric biconical nebulosity associated with the bright B9-AO III star HD 44179. This continuum, known as the *ERE*, consists of a broad emission band between 5400 Å and 9500 Å, peaking at 6100 Å $< \lambda\rho <$ 8200 Å, with a width of 600 Å < FWHM < 1000 Å[4]. The ERE has been seen in a wide variety of dusty environments, the diffuse ISM of our Galaxy, reflection nebulae, planetary nebulae, HII region, and other galaxies. ERE is generally attributed to photoluminescence by some component of the interstellar dust, powered by UV/visible photons. The photon conversion efficiency of the diffuse ISM has been determined to be nearly unity.[5] In a recent work, Van Winckel et al.[6] brought few up-to-date observational evidences on the ERE of the Red Rectangle. Zagury[7] in 2009 showed that the five structures of the nebula's continuum of less than 6700 Å is similar to background spectra and is thus determined either by atmospheric absorption or by light from HD 44179 scattered in the atmosphere. ERE carriers are very likely in the nanometer size range because nanoparticles are expected to luminesce efficiently through the recombination of the electron–hole pair created upon absorption of an energetic photon, since in such systems of nanodimensions, the excited electron is spatially confined, and radiationless transitions that are facilitated by Auger and defect-related recombinations are reduced. Recently some spectroscopic investigations of the Dergaon meteorite[8,9] of type H5 ordinary chondrite with reference to 10 μm (1000 cm^{-1}) and 20 μm (500 cm^{-1}) have been presented. An emission band system in the region 5700–6700 Å from Dergaon stony iron meteorite has also been recently reported.[10] We believe that the emission system corresponds to the part of the ERE reported earlier.[4] In the present work, we report the emission system in the visible sector of the spectrum from a meteorite that fell at Mahadevpur near Namsai town, India[11] (27°.40′ N, 95°.47′ E), at 09:10 am Indian Standard Time, February 21, 2007, and make a comparative study with the emission exhibited by the Dergaon meteorite. This Mahadevpur meteorite belongs to the type ordinary chondrite (H4/5). The meteorite is a heterogeneous aggregate of chondrules of varying types (dominantly porphyritic), and the matrix is made up of mostly chondrules fragments. Chondrule sizes range from 250 to 1300 μm. The various minerals' phases are olivine (Fa_{19}), orthopyroxene (En_{82} Fs_{17} Wo_1), clinopyroxene (En_{57} Fs_8 Wo_{35}), albitic plagioclase (Ab_{87} Or_3 An_{10}), Kamacite, taenite, apatite, and rare chromite. In both chondrules and matrix, olivine grains are homogeneous. Chemical composition and $\Delta^{17}O$ (0.857%) match with H chondrites. Low amounts of trapped noble gases suggest that Mahadevpur belongs to metamorphic grade 4/5.

MATERIALS AND METHODS

The emission (laser-induced fluorescence) is recorded on a classical two-prism glass spectrograph (Asco, India) with a resolution of 5 Å in the region of 6000 Å and a resolution of 10 Å in the region of 4500 Å. The source of excitation is a 25-mW green diode-pumped solid-state laser with exciting wavelength at 532 nm. It may be noted that the Dergaon

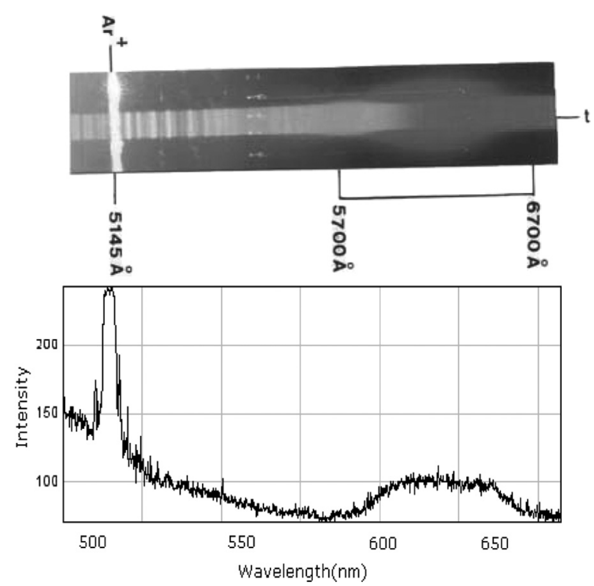

FIGURE 1 Red emission from Dergaon meteorite (type H5 ordinary chondrite).

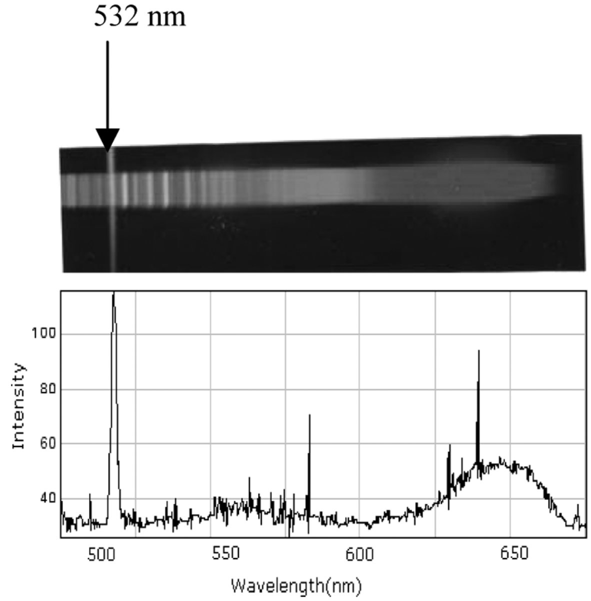

FIGURE 2 Red emission from Mahadevpur meteorite (type H4/5 ordinary chondrite).

meteorite[10] was excited with the help of a 500-mW Argon-ion laser (all lines). The power of the exciting green line was 60 mW. Power of about 20 mW is adequate to excite the fluorescence. The finely powdered sample after removal of the iron part by a magnet is made into a pellet with the help of a hydraulic press and kept between two firmly held glass plates. The optical path or the thickness of the specimen is 0.05 cm. Commercially available color film (Kodak 400 ASA) is used to photograph the spectrum. It may be noted that the fluorescence is very weak. Only color films are capable of detecting it, and for those who are willing to reproduce the work, color films are adequate. The intensity distribution has been measured with the help of software. For this purpose, the spectrograms are scanned with the help of a scanner (Model CanoScan LiDE 25) that is connected with a computer. The software installed in the computer is used for measuring the relative intensity of the bands.

The red emission spectrum from the Dergaon meteorite is shown in Fig. 1, and the corresponding emission from Mahadevpur meteorite is shown in Fig. 2. The intensity distributions are shown with the spectra.

RESULTS AND DISCUSSION

The general features of the laser-induced fluorescence spectrum consist of a diffuse band system in the region 5400–6750 Å and a maximum at about 6100 Å. This emission band system is identical to the emission band system observed in Dergaon meteorite.[10] The band system presumably belongs to the 0.6-μm band system indicated in this case. The question arises whether this 0.6-μm band system has been observed in terrestrial minerals, particularly those consisting of silicates. The answer is definitely "No." We have tried to excite laser-induced fluorescence for a number of silicate minerals but failed to observe any band system in the red–yellow sector of the spectrum. The Mahadevpur meteorite (type H4/5 ordinary chondrite) is also a stony iron meteorite like the Dergaon meteorite (type H5 ordinary chondrite). The present investigation and also the early investigations have indicated that the red luminescence is a characteristic feature of meteorite only. The exact carrier of this luminescence is still not identified. But there seems to be a definite correlation between the 0.6-μm band (the red emission from meteorites) and the ERE of the Red Rectangle.

CONCLUSIONS

In the present work, we have shown the red emission from a recent meteorite known as Mahadevpur meteorite (type H4/5 ordinary chondrite). This red emission is similar to that of Dergaon meteorite (type H5 ordinary chondrite). The significance of the red emission is that the EREs from interstellar space originate from primitive silicates. It is worthwhile to note that we have used five samples of silicates of terrestrial origin to observe emission in the red sector of the spectrum. At least for these samples, red emission was not observed. Since the meteorites in the present work represent samples from outside our solar system, the red emission or the Laser Induced Flourescence (LIF) observed in the present work may be considered as an important observation.

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REFERENCES

1. Molster, F. J.; Waters, L. B. F. M.; Tielens, A. G. G. M. Crystalline silicate dust around evolved stars. *Astronomy and Astrophysics* **2002**, *382*, 222–240.
2. Colangeli, L.; Henning, T.; Brucato, J. R.; Clement, D.; Fabian, D.; Guillois, O.; Huisken, F.; Jager, C.; Jeeesberger, E. K.; Jones, A.; Ledrex, G.; Manico, G.; Mennella, V.; Molster, F. J.; Mustschke, H.; Pirrenello, V.; Reynaud, C.; Roser, J.; Vidali, G.; Waters, L. B. F. M. The role of laboratory experiments in the characterization of silicon-based cosmic material. *Annual Review of Astronomy and Astrophysics* **2003**, *11*, 97–152.
3. Draine, B. T. Interstellar dust grains. *Annual Reviews in Astronomy and Astrophysics* **2003**, *41*, 241–289.
4. Schmidt, G. D.; Cohen, M.; Margon, B. Discovery of optical molecular emission from the bipolar nebula surrounding HD 44179. *Astrophys. J.* **1980**, *239*, L133.
5. Gordon, K. D.; Witt, A. N.; Friedmann, B. C. Detection of extended red emission in the diffuse interstellar medium. *Astrophys. J.* **1998**, *498*, 522.
6. Van Winckel, H.; Cohen, M.; Gull, T. R. The ERE of the ''red rectangle'' revisited. *Astronomy & Astrophysics* **2002**, *390*, 147.
7. Zagury, F. Analysis of the Schmidt, Cohen & Margon (1980) features in the Red Rectangle nebula. *Open Astronomy Journal* **2009**, *2*, 26.
8. Grossman, J.; Zipfel, J. Meteoritical bulletin no. 85. *Meteoritics & Planetary Science* **2001**, (36), A295.
9. Gohain Barua, A.; Baruah, B. R.; Bhattacharyya, S.; Baruah, G. D. Spectroscopic investigation of the Dergaon meteorite with reference to 10 μm and 20 μm bands. *Pramana: J. Phys.* **2003**, *60*, 47.
10. Bhattacharyya, S.; Gohain Barua, A.; Konwar, R.; Changmai, R.; Baruah, G. D. Nature of the emission band of Dergaon meteorite in the region 5700–6700 Å. *Pramana: J. Phys.* **2004**, *62*, 1299.
11. Weisberg, M.; Smith, C.; Benedix, G.; Folco, L.; Righter, K.; Zipfel, J.; Yamaguchi, A.; Chennaouiaoudjehane, H. Meteoritical bulletin No. 94. *Meteoritics & Planetary Science* **2008**, (94), 1570.