Identification of the carriers of the unidentified infrared bands observed in classical novae

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The unidentified infrared (UIR) bands have been observed ubiquitously in various astrophysical environments. The bands consist of a series of emission features arising from aromatic and/or aliphatic C-C and C-H bonds in the mid-infrared wavelength range [1], and therefore, their carriers are considered as being related to interstellar organics. The polycyclic aromatic hydrocarbon (PAH) hypothesis is commonly used to interpret the behavior of the observed UIR bands, however, our knowledge on the true carriers of the UIR bands is still limited. Recently, the imaginary dust particle named Mixed Aromatic Aliphatic Organic Nanoparticles [2], which contain hetero atoms in addition to conventional hydrocarbon models, have recently been suggested as a more realistic interpretation of the carriers. The challenges toward identifying the carriers of the UIR bands are still ongoing. Past studies have shown that the UIR bands observed around novae are somewhat different from those observed in other astrophysical environment; predominantly characterized by the presence of broad 8μm feature [3]. Here we report the success of synthesizing laboratory organics 'Quenched Nitrogen-included Carbonaceous Composite (QNCC)' whose infrared properties are remarkably similar to the UIR bands observed in classical novae. QNCC is produced by rapidly cooling the plasma gas produced from nitrogen gas and hydrocarbons via 2.45 GHz microwave discharge. We found that N/C ratio (atom) of the QNCC is 4-5% based on the measurement with EA/IRMS. X-ray Absorption Near Edge Structure (XANES) analysis of NCC indicates that amine structure is contained in the QNCC. We concluded that the broad feature at 8μm is arising from amine structures in addition to aromatic C-C structures. This result suggests that, in addition to the classical hydrocarbon models, nitrogen inclusion should be the key for the better understanding of the carriers of the UIR bands.

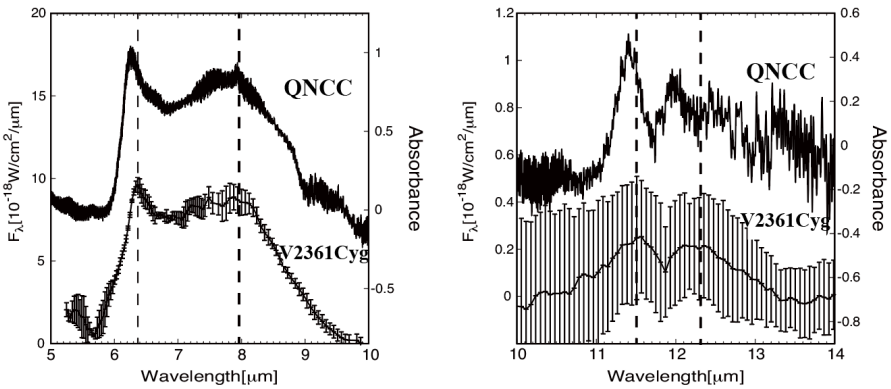

Figure 1: Comparison of the infrared absorption spectrum of QNCC with the UIR bands observed at a classical nova V2361 Cyg on 116 days after the outburst

References

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