COMPLEX ORGANICS IN THE ICY BODIES IN PLANETARY SYSTEMS- ACCEPTED NOTIONS AND NEW IDEAS

I.Simonia[1] and D. P. Cruikshank[2], [1]School of Natural Sciences and Engineering of Ilia State University, Cholokashvili str., 3/5,Tbilisi 0162, Georgia, iraklisimonia@yahoo.com, [2]Astrophysics Branch, NASA Ames Research Center, Moffett Field, CA 94035, USA. *Dale.P.Cruikshank@nasa.gov.*

Introduction: Comets are widely acknowledged to contain some of the most primitive matter in the Solar System, including ices, minerals, and organic material, both simple and complex. A substantial number of previously unidentified spectral emission features observed in comets can be explained as emission by hydrocarbon molecules enclosed in a Shpolskii matrix and forming frozen hydrocarbon particles (FHP) that are nano- to micrometer in size [1]. FHPs contribute both to the emission of spectral lines and bands, and the scattering of sunlight in cometary comae. UV-induced luminescence spectra of a number of prebiotic and biotic molecules exhibit spectral emission lines coincident with unidentified comet lines, and open the possibility of the presence of these complex organic as components of the primitive organic inventory of comets. Organics that appear to have originated in a primitive icy body much larger than ordinary comets are found on three of Saturn's icy satellites. Phoebe, the ~200 km diameter outer satellite of Saturn, originated in distant regions of the Solar System, apparently aggregating and sequestering primitive organic matter from the original solar nebula. Phoebe was later captured as a Saturn satellite, and a relatively recent impact on its surface dispersed material from its interior into circum-Saturn space where it now accumulates on two other Saturn satellites, Iapetus and Hyperion. Future studies may link the Phoebe organics to comet organics, although at present the connection is conjectural.

Main Aspects: Frozen hydrocarbons are components of cometary ice. and it can reasonably be expected that different layers of cometary nuclei are rich with complex aromatics and aliphatics. These hydrocarbons consist of unified structures that include solid solutions, polycrystalline mixtures, and substitutional matrices. As has often been noted [2], there may be a connection of the complex organic chemistry of comets that includes prebiotic and biotic components to the origin of life. Intense solar ultraviolet radiation, the flux of charged particles, and the structure of cometary organics would appear to stimulate luminescence phenomena in organic-rich cometary ice that may be detectable. We have suggested that a Shpolskii matrix in the form of polycrystalline mixtures (PAHs in n-alkanes) might be a significant component of the complex organic substance comprising a major fraction of a comet's mass.

Frozen hydrocarbon matter in cometary nuclei in the form of dense clusters of microcrystals similar to snow may be the main source of fine dispersed organic icy particles of cometary comae. Sources of hydrocarbons irregularly distributed in the inner layers of the cometary nuclei that have not been processed by solar radiation are cometary relicts – witnesses of Solar System formation. During cometary outbursts or flares certain portions of such relict matter is injected into cometary comae where it is subsequently photo-excited. The de-excitation of previously excited molecules (relict molecules) then gives rise to bright luminescence emission. Optical spectra of the cometary bursts could be rich in unknown emission lines or featureless bands especially in the blue range. Photoluminescence spectra of polycyclic aromatic hydrocarbons at temperatures $T > 100$ K have a featureless character in the form of extended blue emission (4000-4900 AA). This extended blue emission in cometary spectra appears to have been first detected by [3]. In the terminology of Bobrovnikoff, “violet type spectra” were detected in several comets. Archived spectroscopic data of the cometary outbursts or flares must be reanalyzed in light of this problem.We have also described the cometary FHPs as a molecularly dispersed structure and substitutional solid solution structure. Such substance might be abundant in terrestrial planets and exoplanetary objects.

Results: We present here two new perspectives on the organic materials in the Solar System. The first concerns the form in which organics are held in comet nuclei, and when ejected into the coma produce optical spectral bands through the luminescence effects of the Shpolskii matrix. In support of this, we show that a number of previously unidentified comet emission bands and lines are coincident in optical wavelength with laboratory measurements of molecules in the Shpolskii matrix, and can therefore identified with sufficient reliability. Several of these molecules might be of prebiological interest. They may constitute part of the ice component of comet nuclei and emerge into the coma as frozen hydrocarbon particles (FHP). As such, they contribute both to the optical (spectral) emission signature of a comet and to the scattering of sunlight that together characterize the coma surrounding the nucleus as the comet warms on approach to the Sun in its elliptical (or parabolic) orbit. Parameters of certain minerals were discussed as well.

References: [1]Simonia, I. (2011) *AJ*, 141, 56 -61. [2] Oró, J. et al. (2006) In *Comets and the Origin and Evolution of Life.* Ed. Thomas, P. J., Hicks, R. D., Chyba, C. F., McKay, C. P. Springer, pp. 1-27. [3]Bobrovnikoff, N.T. (1927) *ApJ*, 66,439-464.