Relationship between polycyclic aromatic hydrocarbons, graphenes and fullerenes in the interstellar medium

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The interstellar medium is abundant of aromatic molecules which is revealed by observations. It is believed that mostly large carbonaceous molecules such as polycyclic aromatic hydrocarbons (PAHs) and fullerenes are formed in carbon-rich asymptotic branch stars. However, some observations indicate that evolution goes on further in the interstellar medium due to influence of different factors (ultraviolet irradiation, erosion, etc.). Thus, abundance of PAHs and fullerenes changes in the ISM and within an individual object. This evolution has not been described in details so far.

This work is devoted to the study of the evolution of PAHs, graphenes, and fullerenes in the interstellar medium. Based on a number of recent experimental and theoretical investigations we developed the model in which PAHs evolve undergoing processes of photodesorption (carbon and hydrogen loss) and hydrogenation. Dehydrogenated PAHs, graphenes, may isomerise or fold into the closed structures - fullerenes. Fullerenes, in its turn, may also be hydrogenated and become fulleranes, can be photoprocessed, i.e. they lose their carbon and hydrogen atoms. The carbon loss leads to the shrinking of the fullerenes to smaller ones.

We calculate the abundance of all three carbonaceous compounds and ratios between each other depending on outer conditions: the gas temperature, intensity of radiation field, number density of atomic hydrogen and carbon, electrons. In addition, we calculate synthetic infrared spectra and ratios between fluxes of the bands specific to PAHs, fullerenes and graphenes. Relied on the calculations we highlight the conditions which are favourable for the mechanism of fullerene formation from PAHs. We applied our model to the photodissociation region Orion Bar with the enhanced radiation field intensity. Fullerenes were detected in this object by specific infrared bands at 17.4 and 18.9 mkm. We compare our estimations of the fullerene abundance in this object with the observations and conclude that our model gives satisfactory results.

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