Condensation of Cosmic Dust far from equilibrium condition

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Homogeneous condensation is a first occurring process to obtain solid materials in Universe. On the Earth, we see only heterogeneous nucleation. Even rain and snow always condense on some dust material via heterogeneous nucleation. On the other hand, there is no or very few heterogeneous nucleation site in the Universe. Therefore, solid materials must condense by themselves homogeneously. However, there is no data that how large supersaturation is required for the condensation. To investigate the homogeneous nucleation and growth process of cosmic dust in laboratory, interferometric observation was attempted for the fist time to the gas evaporation method, which has been a commonly accepted physical production method of nanoparticles as analogs of cosmic dust [1]. In preliminary experiment, silicon oxide, tungsten oxide or manganese was evaporated by electrical heating of an evaporation source in an Ar gas or a mixture gas of Ar and O_2. The evaporated vapor subsequently cools and condenses in the gas atmosphere, i.e., solid grains are obtained via homogeneous nucleation from the vapor phase. As the result, we found the degree of supersaturation for nucleation was extremely high, 10^6-10^7, which was determined from the interferogram. Surface free energy, sticking probability and growth velocity can also be deduced in this system. The condensation temperatures are agreement with the calculated values by the semi-phenomenological nucleation theory [2]. A difference of particle size between the experimental results based on a transmission electron microscope and the theory suggests that the coalescence growth occurred for the case of tungsten oxide.

References

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