CHONDRULES AND PHOTOPHORESIS – OLD FRIENDS MEET AGAIN!

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Introduction: Results from studies on cometary and meteoritical materials show that high temperature minerals and CAIs are not only found in the hot inner regions of the Solar System but also in regions where the temperatures are not expected to be high enough to form these constituents. To explain these observations photophoresis has been proposed [1][2]. Photophoresis is also important for chondrules which might be transported and size sorted by the effect [1].

Experimental Aspects: To verify and quantify photophoretic transport models, we performed microgravity experiments at the drop tower in Bremen and measured the photophoretic force on chondrules, dustmantled chondrules and dust agglomerates. We used chondrules from the meteorite Bjurböle with sizes from ~0.3 mm to ~2.5 mm. The chondrules were released to be free floating in a vacuum chamber at low pressure and then illuminated with a light beam of a focused halogen lamp reaching an intensity of 25 kW/m². The chondrules were observed by two video cameras aligned perpendicular to each other and perpendicular to the light beam. For calibration and to neglect thermophoresis due to temperature gradients within the vacuum chamber, we performed the same measurements with steel and glass spheres.

Preliminary Results: For mm-size, cleaned chondrules (without matrix material attached) the photophoretic acceleration is about 10^{-3} m/s² at ~10 Pa gas pressure and ~25 kW/m^2 irradiance. For chondrules mantled with dust, the linear acceleration is about one order of magnitude larger than for cleaned chondrules. In this work not only the linear acceleration was determined, but (weg) also the influence of photophoresis on the rotation of the particles could be studied. Due to deviations from the perfect spherical shape an analogue effect to the YORP effect (Yarkowski-O'Keefe-Radzievskii-Paddack) could also be observed. Exposed to the light the rotation of the chondrules changed and at least some chondrules were spinning up.

Conclusions: Photophoresis is one of the most important forces in the Solar Nebula. Although it is important, its influence on chondrules has not been studied until now. We present the first meansurements of the photophoretic force on chondrules. Rotation is not a general obstacle to photophoresis as has been argued before but rotation will be determined by photophoresis. In further studies we will carry out a more detailed analysis of the data and supposedly correlate the results to the influence of mineralogical composition for different chondrules.

Refernces: [1] Wurm, G., Krauss, O. 2006, Icarus 180, 487-495. [2] Krauss, O., Wurm, G., Mousis, O., Petit, J-M., Horner, J., Alibert, Y. 2007, A&A 462, 977-987.