Variation of dust properties in a dense filament of the Taurus molecular complex (L1506)

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Recent observations have shown that the pre-stellar cores form preferentially inside the dense molecular filaments observed both with molecular gas lines and the thermal dust far-IR/submm emission. It is thus important to characterise the physical properties of dust and gas in the filamentary structures of the interstellar medium (ISM) and to investigate how the star formation process depends on these initial conditions. Only with knowledge of these properties will we be able to derive reliable and quantitative information about the dense filaments such as the way they are formed, their masses, their structures, or their evolutionary stage.

We observed the L1506 filament, located in the Taurus molecular complex, with the Herschel PACS and SPIRE instruments. An extinction map was also produced using 2MASS data. A detailed modelling of the dust content and density structure of L1506, including full-radiative transfer calculations, was performed using the DustEM and CRT codes (Compiègne et al. 2011, Juvela 2005). We definitively excluded that the emission and extinction profiles of this filament could be explained using the properties of the dust found in the standard diffuse ISM. We showed that the dust far-IR opacity has to increase from the outer to the inner parts of L1506. We interpret this increase in the dust far-IR opacity as dust growth to form large aggregates. To fit the far-IR dust emission and extinction profiles simultaneously along the filament, aggregates with an average size of order 0.4 μm and an increase in the opacity at 250 μm of 1.8 to 2.2 are required. They have to prevail over diffuse ISM-type grains when the local density reaches a few 1000 H/cm^3. The exact numerical value of this threshold naturally depends on the dust model chosen to fit the data. Using a simple approach, we showed that these aggregates may have time to form inside the filament within the cloud lifetime. Our best fitting models finally reveal that the width of the filament varies according to the gas column density.