Scientific results from Herschel/Planck and analysis of open questions for the scientific community

I. Herschel has revealed a rich gas phase chemistry in the diffuse medium

1/ What are the best tracers of molecular hydrogen ? How best to use the spectroscopic measurements to trace the gas structure and assess the atomic – molecular phase balance in the different environments ?

2/ Herschel has revealed new diagnostics of the interaction between matter and cosmic rays. How can we reconcile the information from different molecules ? How to quantify the grain neutralization processes which seem to be a regulating factor ?

3/ In several cases, the dynamics and energetics of matter are clearly coupled to the chemistry. How to make progress in the modelling ? Do we need models that are locally in equilibrium ? or stationnary ? or with a fully coupled treatment ? How to identify the most appropriate modelling methods for the different scientific questions ?

4/ Water data as well as other species (HCl) indicate the importance of non thermal phenomenons, either due to photons or shocks. How to quantify these phenomenons in the laboratory ?

II. Variation of dust properties as shown with Planck and Herschel in the different ISM environments

1) How can we better constrain the dust emissivity (spectral index and opacity) ? How does it depend on dust temperature, the wavelength range and grain physical properties (composition, structure..) ? How better to combine the different approaches : laboratory measurement, theory, modelling .. with the observational results ?

2) How to characterize dust evolution from the diffuse to dense medium, and also within the diffuse ISM ? what are the corresponding physical processes and their timescales ?

3) How can polarization measurements (both in extinction and emission) help to distinguish between the different dust models ?
Which grain alignment mechanism is efficient enough to be consistent with the Planck polarization measurements (high dust polarization fraction) ?

4) What constraints can be provided by X-ray spectroscopy on the dust size and composition ?