Astrophysics Seminars

Tuesday

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Simulating interstellar chemistry on galactic scales

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The chemistry of ions and molecules in interstellar gas plays an important role in galaxy formation, as the chemical abundances determine how quickly the gas can cool. Furthermore, understanding the chemistry is important for interpreting a wide range of extragalactic observations, which often measure emission and absorption lines from individual species. However, existing simulations of galaxy formation typically rely on simplified treatments for the chemistry, assuming chemical equilibrium. In this talk, I will describe a time-dependent chemical model, CHIMES, that we have developed that can be incorporated into hydrodynamic galaxy simulations to follow the evolution of 157 chemical species. I will then present three applications of this model:

1) The effects of non-equilibrium chemistry in simulations of isolated galaxies. We ran a series of simulations of isolated disc galaxies to explore the effects of non-equilibrium chemistry, compared to simulations assuming chemical equilibrium.

2) The origin of molecular outflows in AGN-driven galactic winds. Observations of luminous AGN have detected fast (~1000 km/s) outflows of molecular gas. To study the origin of these fast molecular outflows, we ran idealised simulations of an AGN-driven wind, using the CHIMES model to follow the time-dependent molecular chemistry. We found that molecules can form within the AGN wind, producing molecular outflow rates up to 140 Msol/yr, in reasonable agreement with observations.

3) The effects of flickering AGN on OVI in the circumgalactic medium (CGM). Observations of quasar absorption spectra, for example from the COS-Halos survey with Hubble, are used to measure column densities of OVI in the CGM. However, simulations typically underpredict the observed OVI column densities by a factor of 2-3. While the foreground galaxies in the COS-Halos survey do not host AGN, we show that the ionising radiation from an earlier period of AGN activity can boost the OVI fraction in the CGM even several Myr after the AGN has switched off, due to the long recombination time-scales. This effect can reproduce the OVI column densities observed in the COS-Halos survey.

PHYSICS