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Modelling CO depletion in starless cores

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Abstract. In recent years there has been a dramatic increase in the observational detection of molecular depletion in star-forming dark clouds. In many cases the data is of very high quality and what was once considered a rather hypothetical process is now almost universally accepted as a (the) major cause of the presence of emission 'holes' in molecular maps of dense cores.

However, the interpretation of the data can be severely undermined by uncertainties in the physics and chemistry. This is particularly true in the case of general molecular studies of *active* star-forming regions. For these objects there exist strong degeneracies between various chemical effects (gas-phase time-dependencies, desorption processes and efficiencies, ionization rates etc.) and poorly constrained physics (most particularly in the assumed kinematics and evolutionary history).

Whilst these problems result in unacceptable ambiguities in the case of evolved sources, we can make significant progress for young, near-static cores and using molecular species with simple chemistries. A considerable set of constraints on the free parameters is now provided by the extensive sub-millimetre continuum and infra-red absorption studies of starless cores. These observations give us good descriptions of the temperature and density profiles in these sources. Moreover CO is to a large extent chemically inert, so that any decline of abundance at high densities can (primarily) be interpreted as being a consequence of freeze-out. Thus there are only two major free parameters:- the net depletion/desorption rate and the chemical age of the source. In this study CO abundance profiles are calculated as a function of time for cores whose temperature and density profiles have already been determined. The results are corrected for excitation effects and converted to synthetic maps, assuming typical single-dish beam parameters and source characteristics. A strong correlation with existing depletion maps is found and strong constraints are made on the ages of these sources.

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