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SpS1-Digging in the solar COmosphere with NAC

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1. Introduction

The solar "COmosphere" is an enigmatic region of cold gas (temperatures as low as ∼3500 K) coexisting in the low chromosphere with plasma much hotter (∼7000 K). This zone probably consists of patchy clouds of cool gas, seen readily in off-limb emissions of CO 4667 nm lines, threaded by hot gas entrained in long-lived magnetic filaments as well as transient shock fronts. The COmosphere was not anticipated in classical 1D models of the solar outer atmosphere, but is quite at home in the contemporary 3D highly dynamic view, which one might call the Magnetic Complexity Zone.

COmospheres apparently are an integral part of the atmospheres of virtually all late-type stars, at least those of solar temperature and cooler, as deduced from studies of over-strong CO 4667 nm absorptions in the thermal IR. Early ideas (1980's) concerning the origin of the COmosphere focused on what has been called "molecular cooling catastrophes." Alternatively, the cold clouds might be a transient response to adiabatic cooling phases of large amplitude acoustic disturbances.

COmospheres are significant in the context of this Special Session, because they can have an impact on the general issue of CNO abundances in evolved stars, and particularly the isotopomers that are keys to exploring chemical evolution in the giant branch.

2. New Observations

The best hope for probing the physical structure of COmospheres is in observational studies of the Sun. Great progress has been made over the past two decades in this regard, in boosting spectral and spatial resolution of thermal infrared imaging. Most recently (ca. 2008), the NSO Array Camera (NAC) has been commissioned on the McMath-Pierce solar telescope at Kitt Peak, and very recently (April 2009), a new Integral Field Unit (IFU; developed at California State, Northridge) has been made available for engineering tests. The IFU is an "image slicer" that takes a $6'' \times 8''$ patch of the solar surface, and optically reorganizes it into 25 $8''$-high slitlets, separated by small gaps, and arrays these along the 100 mm entrance slit of the vertical spectrograph. In conjunction with the Horizontal IR Adaptive Optics bench (HIRAO), one now can obtain 2D spectral snapshots of the COmosphere, especially the CO off-limb emissions. In fact, during the engineering run, my colleagues and I were able to obtain off-limb images of the 2313 nm *first-overtone* lines of CO. These features are in general 100× thinner than the 4667 nm fundamental bands, and the fact that they also show the same off-limb signature implies that the 'CO clouds' must occupy a relatively large fraction of the chromospheric volume below about 1000 km. This type of work holds great promise for the future, especially when carried to the 4 m Advanced Technology Solar Telescope (ATST), slated for construction later this year, and operations toward the end of the decade.

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