30 Years of Photodissociation Regions:

A symposium to honor David Hollenbach's lifetime in science

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INVITED TALK

PDRs: Their Prehistory and Possible Future Directions

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Many observations and much theoretical modeling preceded the photodissociation region (PDR) paper of Tielens & Hollenbach (1985). The Orbiting Astronomical Observatory 3 (or "Copernicus Satellite") made ultraviolet absorption measurements of columns of various gas phase species in diffuse and translucent clouds in the early 1970's. These observations in particular spurred a number of theoretical modeling efforts of such clouds, illuminated by the interstellar ultraviolet radiation field. In these early years chemical reaction rates were quite uncertain, and chemical networks small. A number of heating mechanisms were invoked, but in general the models set temperatures without treating thermal balance. The rapid development of infrared astronomy in the period 1975-1985, especially the observations made by the NASA Learjet, the Kuiper Astronomical Observatory (KAO), and the Infrared Astronomical Satellite (IRAS) of the [CII] (158 μm), [OI](63 μm) and infrared continuum emission from molecular clouds illuminated by the ultraviolet radiation from nearby, young, massive stars were the main catalysts in developing the more general theories of photodissociation regions, which included not only diffuse and translucent clouds, but also the illuminated surfaces of opaque molecular clouds. By 1985 the chemical rates and heating mechanisms were much better understood, which allowed self-consistent models that incorporated chemical and thermal steady state, treated the structure of a cloud as a function of depth into the cloud, and allowed predictions of infrared, submillimeter and millimeter radiation from the clouds.

Since 1985 many more observations and models have been made, the subject of this conference. I conclude this contribution with personal speculations on some future directions that PDR research will take. Further work on the PDRs on the surfaces of protoplanetary disks should help reveal the chemical and thermal structure, the surface density distribution, and the dynamics of these evolving disks, aiding our understanding of planet formation. Some possibilities for individual Galactic clouds include further investigations of the cosmic ray ionization rates in clouds as a function of depth into the cloud, the mass contained in the dark or "hidden" H_2 layer, and the carbon chemistry and inventory in clouds. Balloon surveys of [CII], [OI], and [NII] emission in the plane of the Milky Way and in the Magellanic Clouds may allow us to discover how Giant Molecular Clouds are formed and destroyed and provide a template for studies of

more distant galaxies. PDR studies may continue to help us predict the neutral phases of the interstellar media in galaxies, and the factors that control star formation rates in these galaxies. Finally, at high redshift, C^+ seen in (redshifted) ultraviolet absorption or infrared emission (along with redshifted [OI] 63 μm) will provide measures of the star formation rates, and physical conditions in the interstellar media of these distant galaxies and damped Lyα absorbers.

REFERENCES

Tielens, A.G.G.M. and Hollenbach, D. (1985), ApJ, 291, 722