Bohlin R C, Savage B D & Drake J F. A survey of interstellar H I from Lα absorption measurements. II. *Astrophysical J.* 224:132-42, 1978.
[NASA Goddard Space Flight Center, Greenbelt, MD; Washburn Observatory, University of Wisconsin, Madison, WI; and Lockheed Palo Alto Research Laboratory, CA]

The *Copernicus* satellite surveyed the spectral region near Lyman-α (Lα) at 1216Å to obtain column densities of interstellar hydrogen toward 100 stars. A definitive value is found for the mean ratio of total neutral hydrogen gas to selective extinction by the dust of 5.8 x 10^{21} atoms/cm^2-mag. The deviations from this mean value are generally less than a factor of 1.5. The best estimate for the mean total gas density in the solar neighborhood and in the plane of the galaxy is 1.15 atoms/cm^3; those for the atomic hydrogen and molecular hydrogen alone are 0.86 atoms/cm^3 and 0.14 molecules/cm^3, respectively. [The *SCI*® indicates that this paper has been cited in over 490 publications.]

Interstellar Hydrogen

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One summer evening in 1973 after climbing the Navajo and Arapaho peaks in the front range of the Colorado Rockies, I met briefly with my former thesis adviser, Don Morton, in Boulder to discuss possible projects with the Princeton spectrometer package on the recently launched *Orbiting Astronomical Observatory* (*OAO-3*). This satellite, named *Copernicus*, was launched on August 21, 1972, and had high resolution spectrometers for ultraviolet (UV) spectroscopy below the atmospheric cutoff. The U1 and U2 spectrometers on *OAO-3* had 0.05 and 0.2Å resolution, respectively.

Morton, an avid mountaineer who always insists that the best ideas for astronomical research occur on the highest peaks, and I discussed the day's climbs and then agreed that a good proposal would be to study the atomic hydrogen Lα line, the most fundamental spectral transition of the most abundant element. This project seemed ideal because of its scientific importance to studies of the interstellar medium, because of my previous experience with the analysis of Lα absorption lines,[1] and because of my software development skills that would be required to solve a stray light contamination problem of the spectra. This proposal was accepted by the *Copernicus* principal investigator, Lyman Spitzer, another skilled technical rock climber and the chairman of the Department of Astrophysical Sciences, where I was a graduate student, and by Ted Stecher, the supervisor at the Goddard Space Flight Center for my new job beginning in the fall of 1973. To solve the stray light problem required two years of hard work and a lot of advice from Don York.

Because of the success of a pilot study for 40 stars, a larger survey was initiated in collaboration with Blair D. Savage, who suggested measuring the molecular hydrogen in the 1050-1100Å range in conjunction with Lα to get the total gas column densities. As part of the arrangement for getting into the *Copernicus* project, Blair invited me to participate in his approved interstellar studies program on the to-be-launched *International Ultraviolet Explorer* (*IUE*) satellite, which proved to be another extremely fruitful collaboration. Blair was in charge of deriving the molecular hydrogen column densities and wrote the first paper of the series,[2] while I reduced the atomic hydrogen data and wrote this paper (II). The success of this program led to an even larger survey[3] in the later years of *Copernicus* that observed hydrogen in 29 more lines of sight and also measured 10-20 absorption lines of the heavier trace elements toward each of 88 hot stars.

This paper on interstellar hydrogen has stood the test of time because of the importance of the nearly invariant relation between two of the most important constituents of the interstellar medium: the gas and the dust. The scatter of a factor less than 1.5 in the individual measures of the mean total gas to dust ratio demonstrates a precision that is unusual in astronomy, where many important relations between observable parameters are known to only an order of magnitude. In addition, the *Copernicus* measurements of interstellar hydrogen provide information about the inhomogeneous nature of the space distribution of hydrogen in the nearby part of the Galaxy, about the complex relation between the atomic and molecular forms of the hydrogen gas, about the temperature of the interstellar gas in diffuse clouds, and about the total gas abundance required for computing the depletions of the trace heavy elements.

The US space program has not offered any launch opportunities for a telescope that can compete with the old *Copernicus* data for measuring molecular hydrogen.

The archives of *OAO-2* and *OAO-3* data continue to provide valuable supplements to the large set of UV spectra from the currently operating *IUE* spacecraft, while Lyman continues to provide scientific inspiration as well as semiannual collaboration on some challenging rock climbs, even after being officially retired for a few years. The astronomical community is greatly indebted to Lyman for his pioneering work with sounding rocket spectrographs and the *OAO* program, which were necessary precursors to his efforts in initiating the Hubble Space Telescope, which is currently scheduled for launch in December 1989 on the space shuttle.

1. **Bohlin R C.** Mariner 9 ultraviolet spectrometer experiment: interstellar absorption at Lyman-alpha in OB stars. *Astrophysical J.* 182:139-45, 1973. (Cited 10 times.)
2. **Savage B D, Bohlin R C, Drake J F & Budich W.** A survey of interstellar molecular hydrogen. I. *Astrophysical J.* 216:291-307, 1977. (Cited 190 times.)
3. **Bohlin R C, Hill J K, Jenkins E B, Savage B D, Snow T P, Spitzer L & York D G.** A survey of ultraviolet interstellar absorption lines. *Astrophys. J. Suppl. Ser.* 51:277-308, 1983. (Cited 45 times.)