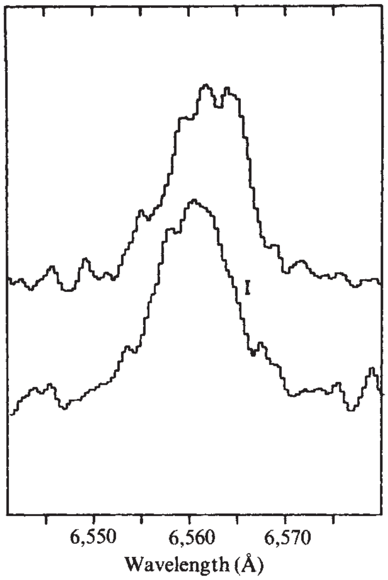

Fig. 4 The Hα line from Hen 715. The 1σ uncertainty is indicated.

that the orbital period of the system is probably greater than ~45 d. The most likely distance for a star of this class is between 1 and 2 kpc which implies a mean X-ray luminosity of $\sim 10^{35}$ erg s^{-1}. Thus for the implied orbital separation of the system the rate of mass loss from HEN 715 required to power the X-ray source by accretion onto a neutron star via a stellar wind is between 10^{-5} and $10^{-7} M_{\odot} yr^{-1}$, for wind velocities between ~500 and 1,000 km s^{-1}.

Table 2 Spectrum of 4U1145−61 1977 day 334 to 347

$A = 0.052$
$\alpha = 0.09 \pm 0.12$
$N_H = <5 \times 10^{21}$ hydrogen atoms cm^{-2}
E_a (keV) = 8.5 ± 0.7 keV
E_T (keV) = 7.3 ± 1.1 keV
$\chi^2 = 42$ for 26 degrees of freedom

It is difficult to account for the two periodicities separated by about 6 s using current models for X-ray pulsators, in which matter is funnelled onto the poles of a rotating neutron star. Both modulations are present when the data are examined in intervals as short as 0.25 d. One possibility which cannot be discounted is that we are observing two separate sources. By using the fact that the pointing direction of the spacecraft drifted on a time scale of days during these observations we find that both modulations must originate from within about 1° of 4U1145−61. There are no other catalogued sources in this area of sky. Thus because of the potential impact of this result on theories of pulsating X-ray sources it is important to demonstrate that both periods do originate from 4U1145−61, and to search for similar phenomena in other X-ray pulsars.

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Hydrogen Lβ and Lα emission lines observed from the interplanetary medium by the Voyager UV spectrometer

OBSERVATIONS of the interstellar medium in the 500–1,700 Å region of the optical spectrum reveals three measurable lines identified as He (584 Å), H Ly-β (1,025 Å), H Ly-α (1,216 Å). The origination of these emissions is dominated by resonance scattering of solar radiation by the interplanetary medium. Here we discuss the first measurements of the H Ly-β line by the Voyager ultraviolet spectrometers and our ability to detect sources other than local singly scattered radiation. The Voyager spectrometers[1] were designed primarily for observation of planetary atmospheric emission.

Resonance scattering of sunlight by neutral hydrogen and helium of the interplanetary medium gives rise to diffuse emission over the whole celestial sphere. The line of sight column density varies with direction because the Solar System is moving through the local interstellar medium and the distribution is perturbed by interaction with solar gravitation and radiation fields. The study of the interaction of the interstellar wind with the Solar System is reviewed in refs 2–4. Measurement of the resonance scattered emission from hydrogen and helium is an important technique in these studies.

Figure 1 shows a spectrum in the 500–1,700 Å region obtained from the UV spectrometer on Voyager 2 in interplanetary cruise. The spectrum is the summation of 696 12-min spectra obtained around day 263 1977 while pointed in a mean direction of 324° α, −23° δ. The two prominent spectral features are the helium 584 Å line and the hydrogen Ly-α line at 1,216 Å. The feature at 1,025 Å is the hydrogen Ly-β emission line and represents the first measurement of this emission line from the interplanetary medium. Estimates of the intensities of the observed features with statistical error, in order of increasing wavelength, are 3.8 ± 0.04, 2.0 ± 0.16, 722 ± 0.5 rayleighs (R). The absolute intensities are estimated to be accurate to ± 15%. We thus have an observed Ly-α/Ly-β intensity ratio of about 360 ± 54. Calculated values of the scattering rates by the two lines of the multiplet give a ratio of about 590. We consider this good agreement in view of the preliminary nature of the analysis. Most of the uncertainty lies in the calculated relative scattering rates. We will have an opportunity to provide much improved estimates at the time of direct observation of the solar spectrum by the Voyager spectrometer.

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The apparent underlying continuum shown in the spectrum of Fig. 1 is due to a combination of cosmic ray events and internal scattering of the optical spectrum entering the spectrometer aperture[5].

There are some uncertainties in the calculation of the scattering rate factors or g values for the hydrogen lines. The most important of these are our knowledge of the relative solar line intensities over the averaged disk of the sun and the Ly-β solar line profile. In the near future it will be possible to improve on these values considerably by using the Voyager spectrometers to obtain simultaneous direct measures of the solar Lyman lines in the same time period as scattering observations. The Voyager spectrometer is capable of direct observations of the Sun at ranges greater than 3 AU. This observation will provide a reference g-value ratio appropriate to observations with the Voyager spectrometers.

Our ability to observe the hydrogen Ly-β emission line at 1,025 Å has important implications both for studies of the local interstellar medium and for the primary function of the Voyager experiment at the planetary encounters. It demonstrates the capability of obtaining measures of emissions as weak as 1 R.

Our ability to measure the pair of resonance lines will be useful in studies of the interplanetary and interstellar medium. Recent measurements from the Pioneer 10 spacecraft at 10 AU show a uniform Ly-α emission background of about 30 R (D. Judge, personal communication) and show no indication of correlation with galactic plane crossing. It has been suggested that practically all of this diffuse emission could be due to multiple scattering of solar Ly-α by interplanetary hydrogen (G. Thomas, personal communication).

If there is a multiply scattered component, the ratio of the intensities of the two H lines will differ from that of the singly scattered component due to the large transition probability ratio, $A_{\text{Ly-}\alpha}/A_{\text{Ly-}\beta} = 5.26$. The possible observation of multiply scattered solar Ly-α radiation is a year or more in the future for the Voyager spacecraft, because single scattering clearly dominates near the Sun. One method of separating the galactic and solar scattered components of Ly-α is to use the Ly-α/Ly-β ratio as a measure of the inclusion of the other sources.

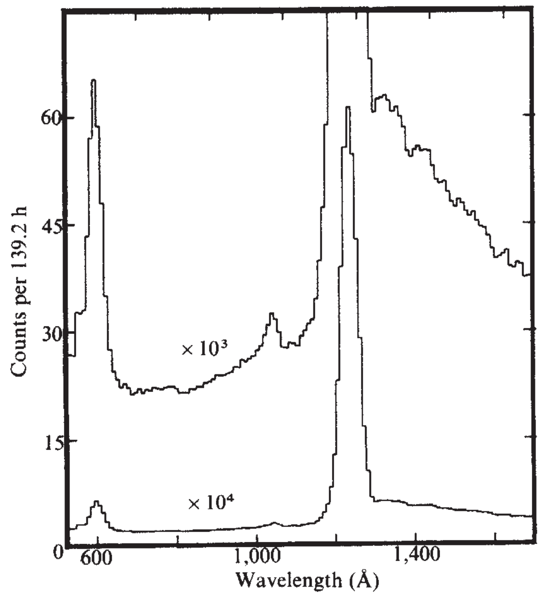

Fig. 1 Voyager 2 spectrum of the interstellar medium in the 500–1,700 Å region. The values, corrected only for detector threshold response, are the summation of 696 12-min spectra. The time intervals are not consecutive because of communication gaps and the occurrence of solar flare events. The mean observational direction was α 324°, δ −23°. The 1,216 Å feature is anomalously wide because of reflection near the edge of a filter in the detector structure.

The changing geometry of the observation as the spacecraft moves away from the Sun may permit separation of these sources. A galactic source will tend to be spatially patchy[6] and is expected to be associated with the observed variation in scattered stellar continuum radiation[7].

We cannot determine whether the observed emissions are entirely due to resonance scattered solar radiation from the available data. However, based on our experience with the Voyager spectrometers to date, we believe it will be possible to put strong limits on, or actually measure, an extrasolar component. We recently presented[7] and discussed the first well defined measurements of the diffuse EUV radiation field in interplanetary space. The maximum observed emission rate at 975 Å was ~0.06 R/Å or 5×10^3 photons cm^{-2} s^{-1} ster^{-1} Å^{-1} (112° α, −13° δ) and we obtain an interpolated value of $\sim6\times10^3$ photons cm^{-2} s^{-1} ster^{-1} Å^{-1} at 1,216 Å. This emission is presumably accompanied by some multiply scattered Lyman series radiation. Draine and Salpeter[8] estimate a galactic Ly-α emission of less than 25 R in general with a maximum of about 100 R in the direction of some supernova remnants. The ability to separate a multiply scattered galactic source from the total Ly-α radiation will be enhanced by measures of Ly-α/Ly-β ratio in observed regions of high diffuse EUV radiation.

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On companions and comets

HARRISON[1] has recently hypothesised that the Sun possesses a companion star, in order to explain an anomaly in the distribution on the sky of pulsars which lose speed very slowly. This is a controversial suggestion mainly because proper motion sky surveys down to at least 14th mag (ref. 2) should have detected such an object. However, one can imagine various objects which might fulfill the constraint of not being visible. Harrison suggested that crystallised white dwarfs, red dwarfs and black dwarfs could be in a bound orbit about the Sun, and neutron stars and black holes would more likely be in an unbound orbit, due to the supposedly explosive natures of their births. Whatever the luminosities of these objects[3] they must produce an acceleration of the barycentre of the solar system to remove the pulsar anomaly. We discuss here the effect of this acceleration on the orbits of the 'new' comets, and how it rules out the possibility of a solar companion in a bound orbit.

According to the Oort theory of comets[4] a cloud of cometary material exists around the Solar System at a distance $\lesssim10^4$ AU.