V. G. Kurt, *The Motion of the Sun in the Interstellar Medium.* Herschel observed at the end of the Eighteenth Century that our sun is moving relative to the nearest stars toward the point $\alpha = 271°$, $\delta = 30°$ in the constellation Hercules at a velocity that is equal, according to recent determinations, to 19.7 km/sec, or 4.2 a.u. per year. Atoms of the interstellar medium will obviously penetrate the solar system in this process. However, it has not been proven to this day that the interstellar medium has no proper motion relative to the nearest stars. We recall, incidentally, that, like the nearest stars, the sun participates in the Galactic rotation at a velocity of 250 km/sec in the direction of $l = 90°$, $b = 0$ (new Galactic coordinates). We studied the solar L_α line (λ 1215.7 Å), which is scattered by neutral atoms of the interplanetary medium, to determine the relative velocity of the sun in the interstellar medium. The observations were made during the period 1973–1976 with instruments carried on Soviet Mars and Venus probes. In 1963, we had become the first to establish the existence of the extra-atmospheric L_α background,[1] and in 1967[2] we determined the anisotropic nature of this radiation (with an intensity drop from 500 to 150 R).1)

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1)1 R (rayleigh) = 10^6 photons/cm^2 sec from the entire celestial sphere, i.e., from 4π steradians.

The nature of this effect was analyzed in[3], but the accidental coincidence of the maximum with the Galactic plane made it impossible at that time to reject a Galactic origin. In 1972, two groups of investigators[4] from the U.S. and France prepared a complete chart of the sky in the L_α line (from the American OGO-5 satellite) and determined from the annual parallax that the region of the maximum lies only 3–5 a.u. from the sun.

Instruments carried on the Soviet "Mars" and "Venera" spaceprobes made it possible to determine the intensity of the radiation and the half-width of the L_α emission line. For this purpose, two cells fitted with lithium fluoride windows and filled with molecular hydrogen and deuterium were placed in front of the detector. When a tungsten heater filament was switched on, the hydrogen and deuterium dissociated into the atoms, which absorbed narrow cores at the line centers (λ 1215.7 and λ 1215.3) with half-widths of 9.2×10^{-3} Å for hydrogen and 6.5×10^{-3} Å for deuterium. The measured ratio F between the detector signals with the heater wire switched on and off is obviously a function of the temperature of the emitting atoms (in this case those of the interplanetary medium) and the projection of the relative velocity onto the instrument's line of sight. Three orientation modes of the "Mars-7" probe were used during eight months of flight in 1973–1974: a) the axis of the probe was oriented toward the sun and the optical axis of the instrument was on a cone with a vertex angle of 120°. The position of the instrument's axis on the cone remained unknown; b) the probe was oriented in the same way and rotated at a speed of $0.05\ \mathrm{deg\cdot sec^{-1}}$. In this case the phase of the rotation could be determined if a region with bright stars crossed the field of view; c) the probe was oriented with all three axes fixed in space. Similar orientation modes were also maintained for the "Venera-9" and "Venera-10" probes. The observed values of J and F were compared with theoretical models. Here it was assumed that the force of gravitation and the light pressure are equal (both effects are proportional to R^{-2}). Actually, the pressure in the L_α line is somewhat larger than the gravitational force, and the hydrogen atoms diverge as they approach the sun. It was also assumed that the chaotic velocity component of the interstellar atoms does not change with the approach to the sun, owing to the absence of interaction of the neutral interstellar component with solar-window protons, which fly radially outward from the sun (their density is ~10 to 1 $\mathrm{cm^{-3}}$, their flux ~$10^8\ \mathrm{cm^{-2}\,sec^{-1}}$, and their velocity ~400 km/sec).

The existence of a galactic (J_0) component of the L_α radiation is also an essential hypothesis. The smallest observed value of F, which equals 0.72, cannot be reconciled with $J_0 > 52\ R$. Figure 1 shows the maximum and minimum acceptable values of V and T. However, there are weighty arguments for the assumption that $J_0 = 0$ (or at least $< 10\ R$), and in this case the values found will be $T = (11\ \text{to}\ 13)\times10^3$ °K and $V = 18$–21 km/sec. The density of the neutral hydrogen atoms at infinity, which actually corresponds to a distance of 100 a.u. (1.5×10^{15} cm) from the sun, will be ~$0.1\ \mathrm{cm^{-3}}$. The direction of the sun's motion relative to the interstellar medium is characterized with an error no greater than 10° by the point with coordinates $\alpha = 272°$, $\delta = -15°$. In this case the true velocity $\mathbf{V}_2 - \mathbf{V}_1$ of the interstellar medium will be 16.3 km/sec toward the point $\alpha = 10°$ and $\delta = 68°$ ($l = 122°$ and $b = 5°$, 5), which is very close to the Galactic plane (Fig. 2). This indicates that the local region of the interstellar medium is moving faster than the stars nearest the sun, which participate in the Galactic rotation. The physical conditions that we found in the interstellar medium agree well with a three-phase model of the medium, namely an intercloud HI zone in which the density n is of the order of $0.2\ \mathrm{cm^{-3}}$, $T = 10^4$ °K, and the electron density $n_e \approx 0.02\ \mathrm{cm^{-3}}$. In dense clouds, $n = 1$ to $20\ \mathrm{cm^{-3}}$, $T = 10^2$ °K, and $n_e = 0.01\ \mathrm{cm^{-3}}$. Observations in the 21-cm hydrogen line give a lower limit of about 10^3 °K for the spin temperature. Observational data on the HeI line at λ 584 Å[5] correspond to a model with $v = 5$–20 km/sec, $n = 0.1 \pm 0.02\ \mathrm{cm^{-3}}$, $n_{\mathrm{He}} = 0.009$–$0.024\ \mathrm{cm^{-3}}$, and $T = (2\ \text{to}\ 10)\times10^3$ °K.

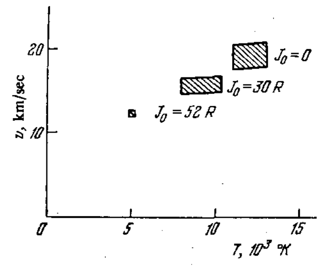

FIG. 1. Acceptable values of parameters of interstellar medium (T and V) vs assumed galactic-background value.

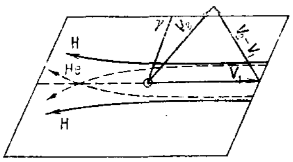

FIG. 2. Diagram of sun's motion. V_1 is the velocity of the sun relative to the interstellar gas; V_2 is the velocity of the sun toward the apex, i.e., relative to the nearest stars; $(V_2 - V_1)$ is the true velocity of the interstellar gas. The paths of hydrogen and helium atoms are shown with consideration of gravitation and light pressure. The focusing region for the helium atoms lies within the orbit of Mercury.

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