two such bundles of negative ions with their charged ends directed at each other enclosing a layer of positive ions. The outer faces of such an ion sandwich make only van der Waals contacts with other ion sandwiches. These sandwiches are of the order of 40 to 50 angstroms thick, depending on the soap under consideration.

The forces leading to an orderly stacking of such layers are relatively weak, and it is not surprising to find that stacking disorder occurs as the solid forms. If the solid is formed slowly, fairly well ordered single crystals can be obtained. If the solid is formed rapidly, the stacking sequence may approach complete randomness with respect to lateral shearing or rotation displacements of the sandwiches with respect to one another.

The latter model, that of random stacking disorder, leads only to two kinds of diffraction maxima, a series of relatively sharp (00l) maxima, unaffected by the stacking disorder, and a series of broad (hkζ) bands. These (hkζ) bands are the diffraction maxima of the two dimensional gratings corresponding to a single sandwich. Sharp (hkl) maxima do not appear for random stacking. It has been possible to interpret a considerable number of x-ray diagrams of soap powders in terms of the (00l) long spacings and broad (hkζ) bands.

A. J. S.

X-Ray Diffraction by Solid Soaps. By A. J. Stosick. *J. Chem. Phys. 18: 1035, August, 1950.*

Upper Air Temperatures from Spectra

When a diatomic gas is emitting light (as in gas discharges, the Northern Lights, and the light of the night sky), the temperature of the gas can be measured from the distribution of light intensity in that part of the spectrum which is due to changes in the rotational energy of the molecules. This method is reliable in many of its applications, almost invariably giving too high values when it does err. But Otto Oldenberg has predicted that under certain very specialized conditions this "rotational temperature" will be too *low* by several hundred degrees. The conditions relate to the character of the molecular quantum states, the gas pressure, and the method of excitation of the gas. Experiments show that this effect does exist—the rotational temperature of an oxygen discharge in a red hot vessel is near freezing.

It happens that much of the oxygen and nitrogen in the earth's upper air (above about 60 miles) has the first two of the properties required for the Oldenberg effect, the excitation mechanism being in doubt. Also there appears to be a serious discrepancy between the very high temperatures computed from radio soundings of the ionosphere and the much lower temperatures computed from the rotational spectra of the night sky light. If the Oldenberg effect should exist in the upper air, the rotational temperatures would be too low by perhaps 150°F. This would suffice to remove the discrepancy between the night sky and the ionosphere temperature data. But if the conditions for this effect are not fulfilled, as is likely, the spectroscopic temperatures may be wrong for other reasons. Night sky temperatures found by this spectroscopic method should be viewed with suspicion until more is known of the processes in the glowing night sky.

L. M. B.

Anomalous Molecular Rotation and the Temperature of the Upper Atmosphere. By Lewis M. Branscomb. *Phys. Rev. 79: 619, August 15, 1950.*

Liquid-Solid

Helium remains a liquid under its saturated vapor pressure to temperatures as low as 0.05° K, and, presumably, to absolute zero. However, upon the application of sufficient pressure (25 atmos. at 1° K to 130 atmos. at 4° K), liquid helium can be solidified, and the thermodynamic properties of this liquid-solid transformation are of particular interest from the viewpoint of the third law of thermodynamics. At temperatures approaching absolute zero, the entropy difference between the liquid and the solid must begin to disappear—with the obvious consequences that both the heat of melting and the slope of the melting pressure curve (dP/dT) must also tend towards zero.

The measurements discussed in these papers involved a direct and accurate determination of the melting pressure as a function of temperature below 2° K, as well as direct measurements of the change in the molar volume on melting. The first set of measurements was used to determine the pressure and showed that even at 1° the variation of melting pressure with temperature is very small, and is decreasing rapidly. The measurements of the change in volume on melting showed a relatively constant value for temperatures up to 1.4°, and then a sudden decrease as the λ-point was approached, followed by a slow decline with increasing temperature in the helium I region above the λ-point. Both these results, when combined with previous data for temperatures above 2° K, show the change in character of the transition as the liquid changes at the λ-point.

The behavior of the heat of melting, as calculated from these results, confirms directly the predictions of the third law of thermodynamics. At 1° the melting heat has decreased to one percent of its value at the λ-point, and is approaching zero very rapidly. The difference in internal energy of the liquid and solid can also be calculated, and is found to pass through zero at 1.7° and then to become negative at lower temperatures—a unique situation as far as liquid-solid transitions are concerned. The explanation can be found in terms of the high zero point energy of the helium atoms.

The liquid-solid transformation at absolute zero is interesting in itself. To solidify the liquid helium, no heat need be removed, but the pressure has only to be increased slightly to cause the rearrangement from helium II atoms to the crystalline solid. Similarly, to melt this "ordinary" solid, no heat is required, only a slight change in pressure. The purely mechanical nature of this phase transformation is something very unusual in the study of thermodynamics.

C. A. S.

The Liquid-Solid Transformation in Helium near Absolute Zero. By F. E. Simon and C. A. Swenson. *Nature, 165: 829, 1950.* By C. A. Swenson, *Phys. Rev. 79: 626, August 15, 1950.*