radio noise near the terrestrial poles (see, e.g., Murcray, W. B., and Pope, J. H., *J. Geophys. Res.* **65**, 3569, 1960; Brown, H. E., and Cairns, G. G., *Nature* **194**, 962, 1962).

The ions that pass through the outer zones of the earth's atmosphere without suffering substantial changes in their trajectories are then submitted to interaction with the charged particles of the ionosphere or to collisions with neutral particles of the inner layers. The effects of the first type of interaction have been analyzed in many papers (see Dalgarno, A., *Ann. Geophys. (Fr.)* **17**, 16, 1961); this is not the case with the latter. Here we consider the second type of interaction exclusively. To study the radiation emitted in such collisions between ions and neutral particles we assume that: (a) the time interval Δt during which the collision takes place is in accordance with the uncertainty relation $\Delta E \Delta t \sim h$, where h is Planck's constant and ΔE is the change of energy in the colliding particles and of the same order of magnitude as the radiation emitted by the incident ion; (b) v_0 the speed of the particle before the collision, decreases to zero after the collision and the acceleration of the particle is constant during the interval Δt , its value being $v_0/\Delta t$; (c) the maximum value of the irradiated energy is equal to the kinetic energy of the particle before the collision, i.e., $\frac{1}{2}mv_0^2$; and (d) the frequency ν of the radiation emitted in the collision is in agreement with the quantum condition $\nu = \Delta E/h$. With such conditions, taking the accepted values for v_0 [see, for example, *The Sun*, edited by G. P. Kuiper (University of Chicago Press, Chicago, 1953), p. 437], and in accordance with the classic expression [see Richtmyer, F. K., and Kennard, E. H., *Introduction to Modern Physics* (McGraw-Hill Publishing Company, Inc., New York, 1947), 4th ed., p. 66] for the radiation emitted by a particle which is totally stopped, we obtain the following values for the wavelength λ in centimeters:

v_0 (cm/sec)	H	Ca
10^7	2800	700
10^8	2.8	0.07.

A large proportion of these values for λ lie in the range studied by the radio-astronomy. For this reason the effect of the considered collisions in the zones of the atmosphere near a radio-observatory may influence the observations made with their equipment, especially during the time of great solar activity. The authors have not, in the bibliography consulted, found any previous references to this type of process of generation of radio waves in the atmosphere.

Neutron Stars and Galactic X-Ray Sources.

HONG-YEE CHIU, *Goddard Institute for Space Studies*.—Recently some discrete x-ray sources have

been identified in rocket experiments (Gursky, H., Giacconi, R., Paolini, F. R., and Rossi, B., *Phys. Rev. Letters* **11**, 30, 1963; Boywer, S., Byron, E. T., Chubb, T. A., and Friedman, H., *Nature* **201**, 1307 1964). It has been suggested that neutron stars are x-ray sources (Chiu, H.-Y., *Ann. Phys.* **2**, 364, 1964), and atmospheric models including neutrino emission processes are now available (Chiu, H.-Y., and Salpeter, E. E., *Phys. Rev. Letters* **12**, 413, 1964); Morton, D., *Nature* **201**, 1308 1964). In general, their core temperatures are of the order of 10^9 °K, with a nondegenerate layer of 1 m in which the temperature drops to 10^7 °K at the surface. The photosphere is only 1 cm thick. In order to differentiate neutron stars from other extended x-ray sources (such as were considered by Morrison), it is necessary to study their angular size and their spectra. We report on a possible x-ray spectrograph for use in space, using the principle of total reflection telescopes (such as was considered by Rossi and also by Ziock).

A Study of Pulsation in RR Lyrae Models.

ROBERT F. CHRISTY, *California Institute of Technology*.—Methods of calculation involving numerical integration of the partial differential equations of motion (Christy, R. F., *Rev. Mod. Phys.* **36**, 555, 1964) have been applied to a series of RR Lyrae models. The series of envelope models explores the dependence of pulsation on the mass, luminosity, effective temperature, and hydrogen-helium ratio of the models. Particular emphasis has been placed on discovering observable measures of the nature of the pulsation and how they correlate with effective temperature and composition. Four new measures of this kind are being explored. Two of these—the ratio of radius to luminosity amplitudes and the phase difference between the velocity and luminosity curves—are referred to in the reference. Two additional quantities—the first moment in time of the positive phase of the luminosity and of the negative phase of the velocity—are also being explored. Systematic variations of all four quantities have been found with effective temperature and composition. For example, the difference in shape of the luminosity curve between *a* and *b* type variables corresponds to the variation seen with effective temperature (type *a* being earlier). In addition, the characteristic double maximum in the light curve frequency seen in type *c* variables is found in the first harmonic models. This feature and the second (small) maximum of the light curve in other RR Lyrae variables is discussed. The phase delay for the first harmonic models is also characteristically different, the luminosity rise coming earlier than in those oscillating in the fundamental mode. Detailed results of this survey are reported.