We have also

$$w=\gamma H \exp(-y/2h_1)\left\{C\left[\left(\frac{h_1}{H}-\frac{1}{2}\right)\cos\frac{Vy}{2h_1}+\frac{V}{2}\sin\frac{Vy}{2h_1}\right]+D\left[\left(\frac{h_1}{H}-\frac{1}{2}\right)\sin\frac{Vy}{2h_1}-\frac{V}{2}\cos\frac{Vy}{2h_1}\right]\right\}-\frac{i\sigma\Omega}{g}.$$

$$i\sigma\frac{p}{\rho_0}=\frac{1}{2}gH\left[(C+VD)\exp(-y/2h_1)\cos\frac{Vy}{2h_1}+(D-VC)\exp(-y/2h_1)\sin\frac{Vy}{2h_1}\right]-i\sigma\Omega.$$

The continuity of χ and w gives us C and D. By substituting the appropriate value of y, we find the pressure variation at 16 km, which is taken to be the bottom of the meson-producing layer. If p_0 is the pressure at 16 km when the atmosphere is in equilibrium, and $p+p_0$ the pressure when it is disturbed, and if h is the displacement of the isobar, on which the pressure is p_0, from the equilibrium position, then considering the equilibrium of the layer between 16 km and $16+h$ km, $p=g\rho_0 h$, i.e., $h=p/g\rho_0$, neglecting the variation of density ρ_0 in the layer.

We thus find that h varies harmonically with an amplitude of 101.3 cm. Taking the mean free path (decay) of mesons to be 8.5 km,[4] we obtain in the usual way for the amplitude of the semidiurnal variation in meson intensity at the earth's surface due to lunar effects 0.012 percent, the amplitude decreasing with increasing latitude. This may be compared with the result reported recently by Duperier,[5] who obtains from his records (0.023 ± 0.011) percent for the lunar semidiurnal amplitude of the cosmic-ray intensity variation.

We hope to publish elsewhere in the near future a more comprehensive theory of solar and lunar effects on cosmic rays.

[1] A. Duperier, Proc. Phys. Soc. **57**, 464 (1945).
[2] C. L. Pekeris, Proc. Roy. Soc. **A158**, 650 (1937).
[3] A. W. Mailvaganam, Proc. Phys. Soc. to appear shortly.
[4] B. Rossi, H. V. N. Hilberry and J. B. Hoag, Phys. Rev. **56**, 837 (1939).
[5] A. Duperier, Nature **157**, 296 (1946).

Removal of the Electron Beam from the Betatron*

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THE electron beam has been extracted from the University of Illinois 22-Mev betatron by means of a simple laminated iron channel. The iron structure is about 10 cm long and 0.7 cm high with a 1.75-mm by 5-mm channel in the edge facing the orbit. It is placed just outside the point where the magnetic field decreases as $1/r$ and a few centimeters outside of the equilibrium orbit. At the entrance end the channel is tangent to the orbits so that electrons entering it proceed in approximately a straight line to the other end where they emerge in a very weak magnetic field.

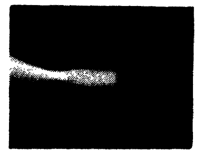

Fig. 1.

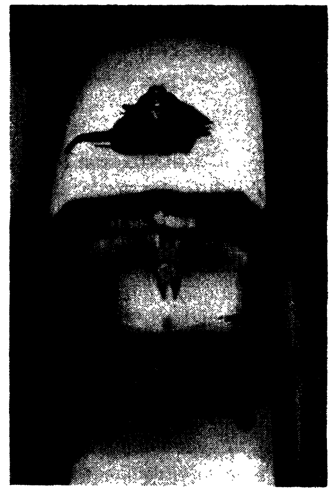

Fig. 2.

When an electron orbit is expanded into the region where the field falls off faster than $1/r$, the radial focusing forces disappear and the orbits spiral outward automatically. Spirals having a pitch of 1 mm to 5 mm have been observed. Electrons can be caused to enter the channel by the spiralling action. They are forced out to the spiralling region by the orbit expander.

An injector above the plane of the orbit was used so that the outward motion of the electrons was not obstructed. Tests with injectors placed inside the equilibrium orbit show that this type of injection should also be suitable.

A short time after the extraction scheme began to operate, the glass window 2 cm beyond the exit of the channel showed a sharp brown image of the channel with slight spreading of the beam. Multiple scattering in the $\frac{1}{16}''$ glass window spread the beam beyond. At one meter from the channel an ionization yield of over 100 r per minute was obtained.

When 4 inches of Pressdwood were used to absorb the beam, the ionization intensity dropped to about 1 percent, indicating that the x-ray intensity is very small. Photographic effects behind various thicknesses of Pressdwood gave ranges in agreement with the electrical calibration of the betatron's energy. The abrupt drop of photographic density at the end of the range is good evidence that the effects are caused by electrons.

Figure 1 shows the beam cross section as it emerges from the glass window and passes through a photographic film. The rectangular end is about the size of the channel and the fan-shaped end is composed of electrons not quite captured in the channel.

Figure 2 shows the window of the porcelain vacuum tube. The end of the iron channel is visible and the dark spot produced by the beam penetrating the glass can be seen at the inside edge of the window.

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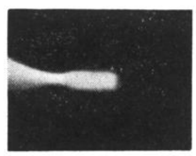

FIG. 1.

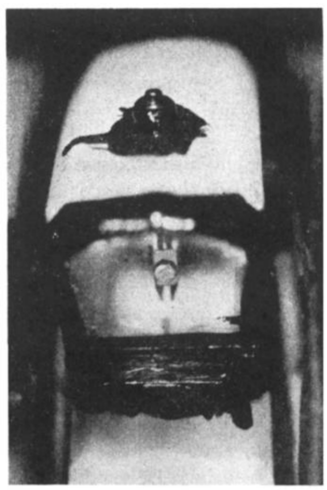

Fig. 2.