Where Can Negative Protons Be Found?

The suggestion has variously been made, that in some distant stars or nebulae the identities of the carriers of positive and negative electricity might be reversed. A hydrogen atom in such regions would be built up of a negative proton and a positive electron.

If the above idea is correct, one should find negative protons which enter our atmosphere from interstellar space. We know indeed that elementary particles of all kinds are emitted from most of the nebulae which can be seen with the modern telescopes. *Common novae* and *super-novae* which from time to time flare up in these nebulae emit great numbers of fast elementary particles. Common novae, whose average absolute magnitude is -5.8 expel gaseous shells with velocities of the order of 100 to 2000 km/sec. Super-novae, whose average magnitude is of the order of -15 emit ions whose velocities are probably considerably greater than 10,000 km/sec. In any case, because of the generality of the nova phenomenon the earth atmosphere will be invaded by all kinds of ions, some of which have traveled hundreds of millions of light years.

A rough estimate indicates that on the top of the earth's atmosphere the number of atoms coming from novae is of the order of 0.1 per cm^2 and second. Because of the abundance of hydrogen in the stars many of these particles should be ordinary protons, as well as negative protons, provided that the latter exist in stars nearer than that critical distance ($>2\times10^9$ light years) through which the energy of elementary particles probably is radically reduced by "redshift" effects or absorption. We conclude: (1) Negative protons should be looked for in cloud chambers at high altitudes. (2) Hard γ-rays of the order of one to two billion volts will be produced in the upper atmosphere if mutual annihilation of positive and negative protons takes place. (3) An east-west effect of the observed sign can be expected due to the dissimilar penetration of positive and negative protons into the atmosphere.

F. ZWICKY

California Institute of Technology,
Pasadena, California,
June 6, 1935.