

CALIFORNIA INSTITUTE OF TECHNOLOGY

CHARLES C. LAURITSEN LABORATORY OF HIGH ENERGY PHYSICS

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Dr. K. R. Shoulders
Institute for Advanced Studies
1301 Capitol of Texas Highway, S.
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Austin, TX 78746

Dear Dr. Shoulders:

When you were in my office I could not see how 10^{10} or 10^{11} electrons could be kept as a ball in a vacuum without ions. So I was skeptical and didn't let you tell me about them. I must apologize for it has come to my attention that it is indeed possible. In a uniform magnetic field a group of electrons rotating at the Larmor precession frequency ($\omega = eB/m$) feel, from the point of view of an observer rotating with them, a force toward the axis which would in size be equal to the centrifugal force expected from this rotation ($m\omega^2 r$) but directed inward. Then an electric quadropole could be used to hold them by repulsion along the axis, as long as the force away from the axis generated by the quadropole does not exceed the previously noted confining force from the magnetic field.

By adjustment of the size of the quadropole field the forces of confinement can be made equal in all directions - just as if there were a density of ions in a vacuum - and a rotating sphere of charge is possible.

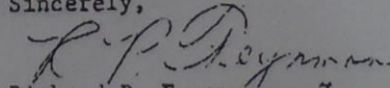
The size seems to be governed by the electric field available without breakdown, but it looks like a reasonable possibility is 2×10^{11} electrons in a magnetic field of several hundred gauss.

Now that I understand how it might work I should be glad to discuss it again anytime you wish.

My informant was the physicist Curtis Michel, who told me that ions were confined this way at the Bureau of Standards (ions are easier, the electric field needed is less and B can be raised to, say, 15,000 gauss). Some work of this kind was started ten years ago at UCSD by a Professor M (I forget the full name) but at first the phenomena seen were not understood.

I again apologize for my skepticism which prevented me from hearing about something very interesting.

Sincerely,



Richard P. Feynman

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