NEWTON'S 2ND LAW All Eyes (and Ears) on Jupiter

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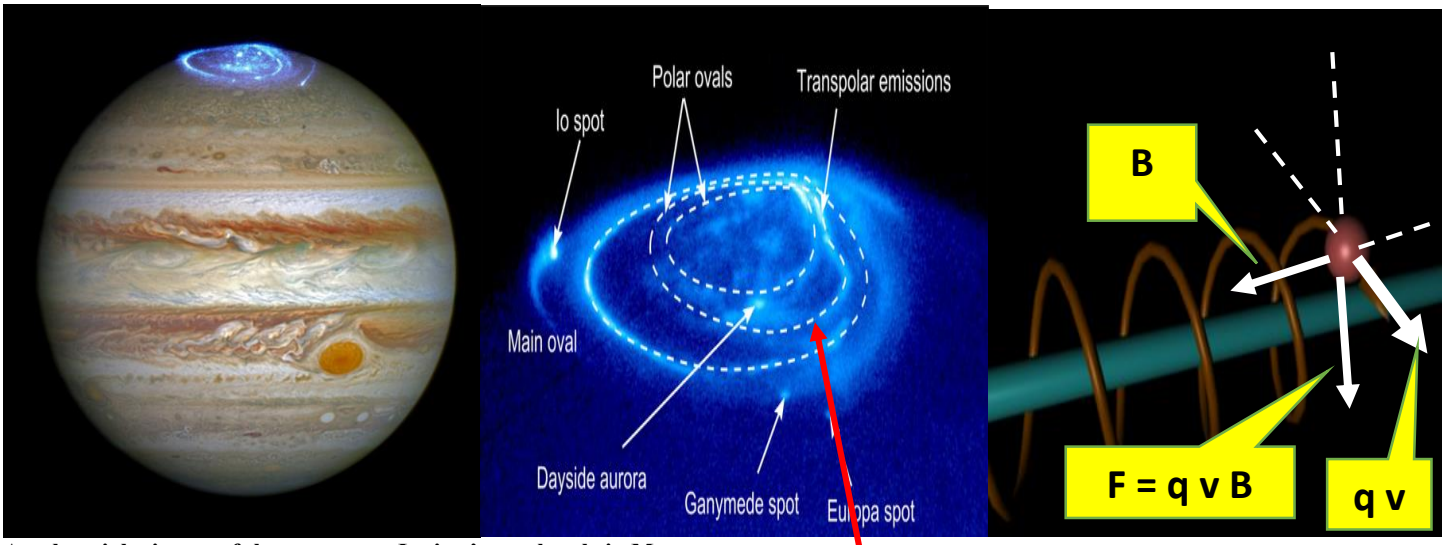

An ultraviolet image of the auroras at Jupiter's north pole in May superimposed on top of an 2014 image made by the Hubble Telescope.

As NASA's Juno spacecraft closes in for its Monday arrival at Jupiter, many other eyes are also staring at the solar system's largest planet. Data from about 25 observatories — including some of the largest on Earth, like the W. M. Keck Observatory in Hawaii, and in orbit around Earth, like the Hubble Space Telescope— will aid scientists in interpreting the data that Juno is expected to gather as it swoops close to the cloud tops of Jupiter over the next 20 months.

It has taken Juno nearly five years to reach this point in its journey. With Juno providing the first good look at Jupiter's poles, Dr. Fletcher is curious as to whether huge hurricane-like storms rage, similar to what has been observed in Saturn's polar regions. The auroras — glowing patterns powered by charged particles slamming into the atmosphere — might also affect the weather. To gain more data on the auroras, the Hubble Space Telescope has been staring at Jupiter for 45 minutes every day for the past month. At Earth, auroras light up when solar wind particles slam into molecules of air near the polar regions. **At Jupiter,(((the charged particles come mostly from a different source: the volcanos of Io. Jupiter's powerful magnetic fields then accelerate the particles into the planet's atmosphere))).**

At times, the auroras are subdued. At other times, **they are "almost like fireworks going off in the ionosphere of Jupiter**," said Jonathan Nichols, a University of Leicester scientist who is leading the Hubble study. One of the things that is unknown is how much the solar wind contributes to Jupiter's auroras. "We'll be working on that over the next few weeks and months," Dr. Nichols said.On Earth, **auroras appear over an area about as large as the United States. Jupiter's auroras, like everything else there, are vastly larger, about as wide as five Earths."** But we've never been able to get up close and really observe these processes.

On Jupiter, charged particles ultimately hit magnetic fields which direct the particles to the north and south poles. The charged particles excite atoms and molecules in the atmosphere, and when these atoms and molecules return from their excited state, they emit a photon: a small burst of energy in the form of light. In fact, the colors of the aurora depend on the atoms and molecules present in the atmosphere. Jupiter's aurora is especially interesting to study because the planet's magnetosphere is roughly 20,000 times stronger than the Earth's. For this reason, the **Jupiter's auroras are also hundreds of times more energetic than the ones we have on our planet.**

INTRODUCTION: The magnetic field(B) of earth is about 50 X 10^{-6} N/A m. Jupiter's magnetic field being 20,000 times stronger = (2 X 10^{4}) (50 X 10^{-6}) = 1 N /A m = B_{Jupit}
In the upper right graphic we have a proton charged particle (q = 1.602 X 10^{-19} coul.) traveling at v = 10^{4} m/s perpendicular to Jupiter's magnetic field $B_{JUPITER}$ = 1 N/Am

QUESTION: (a) Find Force F on charged particle? F = q v B
(b) Show how the units work out to result in N (Newtons)
HINTS: N = kg. m./s^2 , Amp. (A) = coul./s.
ANSWERS: (a) 1.6 X 10^{-15} N,
(b) F = q v B = (~~coul. m/s~~)(kg m/s^2)1/ [~~coul/s] m.~~ = kg m/s^2 = N