not just the rod cells, but also the retinal pigment epithelium and the retina's other light detectors, the cone cells, could be damaged.

Or it may be that an altered ABCR protein does its job just fine, but is itself not recycled properly and so accumulates inappropriately. "So you are left with junk that may be toxic," suggests genetic epidemiologist Margaret Pericak-Vance of Duke University in Durham, North Carolina. "There are a number of possibilities."

To try and sort through them, several teams are knocking out the *ABCR* gene in mice to create animals that make no ABCR at all. By seeing what kind of defects result, they may be able to figure out what the protein does. Others are trying to find out what molecule the ABCR protein transports, if indeed that is what it does.

At the same time, there's a push to find out just how common *ABCR* mutations are among people with macular degeneration. "We have to look at large numbers of well-characterized patients and controls and really determine the prevalence of this gene in well-defined cases," says Kupfer. Moreover, Pericak-Vance points out that researchers also need to find out whether the age at which patients lose their vision depends on which mutations they carry. Answers to these questions will help determine whether screening for mutations in this gene is warranted.

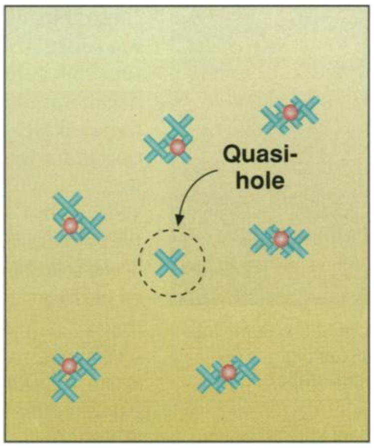
But even if this gene proves to have a smaller role in age-related macular degeneration than this first result implies, it is a break in what had been an intractable case, says Dean: "This is the first chink in the armor of a disease that's been resistant to figuring out what's going on."

–Elizabeth Pennisi

PHYSICS

Slicing an Electron's Charge Into Three

As everyone learns in high school, electric charges come as multiples of an indivisible unit: the charge of an electron. But two groups of physicists have demonstrated an exception. As an Israeli team announced in last week's issue of *Nature* and a French team will report in the 29 September *Physical Review Letters*, charge in a thin layer of electrons subjected to a high magnetic field and chilled to nearly absolute zero can come in units of exactly a third of an electron.



Quasi-particles. In a sea of electrons and magnetic field, each electron teams up with three vortices; extra vortices form positive "holes" carrying fractional charge.

Counterintuitive as it is, the result isn't a surprise to solid-state physicists. They have gotten over their shock during the 14 years since fractional charges were first predicted as part of a theory to explain a puzzling phenomenon called the fractional quantum Hall (FQH) effect. But actually observing a fractional charge—a manifestation of fractionally charged "quasi-particles" that take shape in the quantum-mechanical soup of electrons and magnetic field—is a thrill nonetheless. "It's exciting that the prediction has been confirmed," says Charles Kane of the University of Pennsylvania. "You can sort of imagine those quasi-particles going blip, blip, blip, and I think that makes it seem more real."

The generic Hall effect has been part of physics since 1879, when Edwin H. Hall reported that a magnetic field applied perpendicular to a current-carrying wire creates a voltage across the wire's width. This Hall voltage develops, as physicists later realized, because the field causes electrons to pile up on one side of the wire. In the 1980s, physicists discovered a quantum variant of the effect: Under extreme conditions—when electrons were restricted to an ultrathin layer of a solid at very low temperatures and high magnetic fields—increasing the magnetic field caused the voltage to increase in discrete steps, rather than continuously.

Even more surprising, the plateaus in the Hall voltage appeared when the ratio of current along the layer to the voltage across it—known as the Hall conductance—reached multiples of a specific value. Physicists soon managed to explain the plateaus at integer multiples, known as the integer quantum Hall effect. But the FQH effect seen at higher magnetic fields, in which the plateaus correspond to fractional multiples such as 1/3, 2/3, 2/5, and 3/7, "was puzzling for quite a while," says physicist Rafi de-Picciotto of the Weizmann Institute of Science in Rehovot, Israel, a member of the Israeli team.

In 1983 Robert Laughlin, now at Stanford University, proposed an explanation for the FQH effect, and although the theory was widely accepted, it included a strange concept: fractional charges. Laughlin proposed that in the FQH effect the electrons in the layer form an exotic quantum-mechanical state in which they move collectively. In this state they coexist with vortices, pointlike objects resembling tiny whirlpools around which the electrons circulate. Electrons are fermions, particles that normally can't occupy the same quantum state, but when each electron teams up with an odd number of vortices, they form aggregates that can coexist in a single quantum state.

The number of vortices increases with magnetic field. At particular values of the field, there are just enough vortices for all of the electrons to form one of these stable arrangements, say, an arrangement in which each electron is "bound" to exactly three vortices. If another vortex is introduced, by increasing the magnetic field, for example, the electrons move away from it, to maintain the same ratio of electrons to vortices everywhere else. By doing so, they open a gap in the negative charge, and a positive charge corresponding to exactly a third of an electron's is left behind.

These fractionally charged quasi-particles can carry electric current in the FQH state. Meanwhile, because the background "sea" of electrons bound to vortices clings to stable configurations in the face of increasing magnetic field, the Hall conductance remains constant, as the FQH effect demonstrates.

Laughlin's picture has withstood every test since he proposed it, but physicists still had a hard time accustoming themselves to it. "It is very difficult to imagine that electrons will somehow divide, because they are really elementary particles," says de-Picciotto. "What [the physics community] wanted to see was a direct observation of the charge."

The two research teams—one led by Michael Reznikov of the Weizmann Institute and the other by D. Christian Glattli of the Commission of Atomic Energy in Saclay, France—set out to look for the fractional charges by measuring fluctuations in the current through an FQH system chilled to within a tenth of a degree of absolute zero. The method is like gauging the size of hailstones by listening to them hit a tin roof, Kane and Matthew Fisher of the University of California, Santa Barbara, explain in a commentary accompanying the *Nature* paper. By measuring a current so small that the size of the individual "hailstones" could be determined, the researchers found they corresponded to charges just one-third that of an electron.

De-Picciotto is delighted with the result, but he confesses to a little regret that it is so neat: "It would have been nice if we could identify something new which is not predicted by any theories, and then it would make people think even harder in order to try and explain it."

–David Ehrenstein