

itself. The result of the subtraction is shown by curve b. Curve c displays the $2f$ response after a linear background subtraction. The bottom curve shows the Fourier transform of the field dependence, indicating the peak in response for h/e and $h/2e$ oscillations. The data show the predicted h/e oscillations, but the magnitudes of the responses are quite striking. They correspond to values at $T = 4.5$ mK in the range $0.3\text{--}2.0 e v_F / L$. These results are nearly two orders of magnitude greater than the value of e/τ_D predicted by most theories to date, which do not take into account interactions between electrons.

The direction of the current is of some interest. Chandrasekhar and his colleagues determined the direction of the induced moment for two of their three rings and found that they were paramagnetic. One would expect any given ring to have a 50:50 chance of being paramagnetic, but two rings hardly constitutes a statistically significant sample. How do these randomly oriented signals from individual rings add in a large sample such as the array measured at Bell Labs? Ambegaokar and Eckern predicted that the sign of the array's response would be the same as that of the force between the electrons, that is, that one would find a diamagnetic signal in the case of superconducting rings and a paramagnetic signal for normal metal rings. Lévy and his colleagues feel now that they cannot make any definitive statement about the direction of the moment for their array. The IBM group is planning some experiments on arrays to explore some of these issues. On the other side of the Atlantic, Lévy is studying other forms of orbital currents in gallium arsenide structures in which electrons move ballistically and collide elastically with the walls.

Clearly the new results challenge the theorists to refine further their understanding of these mesoscopic rings. But the calculations are not easy. Ambegaokar commented to us that calculating the size of the current is equivalent in difficulty to calculating the critical temperature for superconductors. Imry feels that the current discrepancy is no big mystery: The theories are sufficiently oversimplified at present that it would be no surprise if they had neglected an important factor. One possibility is the long-range component of Coulomb interactions in such thin systems. Eckern and Albert Schmid (University of Karlsruhe) have calculated a large current based on a theory that incorporates electron-electron interactions.⁸ But the

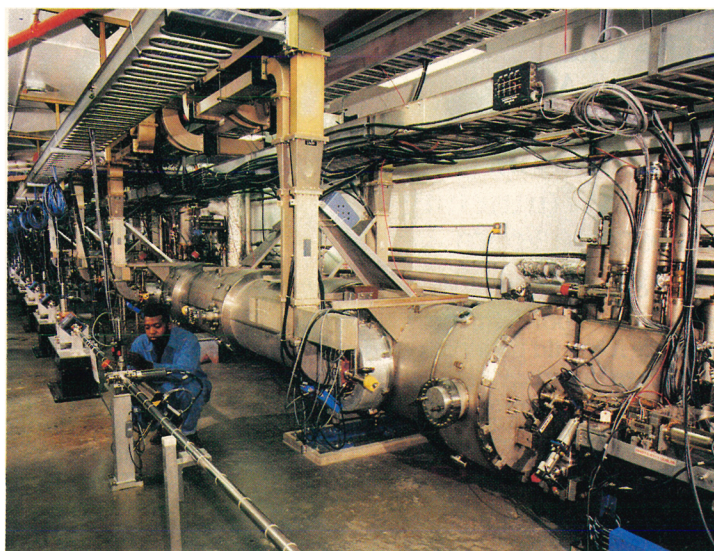
theoretical picture is still far from settled.

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CEBAF Injector Passes All Tests



The Continuous Beam Accelerator Facility in Newport News, Virginia, is scheduled to start providing nuclear experimenters with 4-GeV electrons in the summer of 1994. CEBAF's 45-MeV injector, seen in the photo above, is the first major component of the accelerator to be finished. By the end of last year, after 700 hours of test running, it had met or exceeded all design specifications, generating an average beam current greater than $200 \mu\text{A}$ with a normalized emittance of 0.5 mm mrad .

The photo shows the downstream end of the injector, with its two consecutive 8-meter-long cryogenic modules running near the wall. Each module houses eight superconducting rf cavities, each of which accelerates the traversing electrons by 2.5 MeV. The rf power comes down through the rectangular waveguides from a klystron gallery above. The technician is attending to a thin tube that is part of a temporary, experimental

recycling beam line for sending the 45-MeV electrons back for a second pass through the injector.

In the completed accelerator, the 45-MeV beam emerging from the injector will circle the racetrack-shaped main ring with its two 200-meter superconducting linacs five times, picking up 0.8 GeV on each circuit. Unlike conventional copper rf cavities, superconducting cavities can run in a continuous (as distinguished from pulsed) mode.

Nuclear experimenters are particularly keen on having continuous electron beams because many of their scattering experiments require coincidence measurements. Crowding all the events into millisecond pulses produces too many spurious coincidences. CEBAF will be the first continuous-beam facility with electron energies high enough to probe the role played by quarks and gluons in nuclear phenomena.

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