method that heterochromatic regions on homologous chromosomes are associated with one another," Karpen says.

Other researchers familiar with the work, which both teams have presented at meetings, say the two sets of results complement each other very well. "I think it's important that there are two halves to this story," says Orr-Weaver. "Karpen sees the end product of the meiotic event, while Hawley looks at an intermediate stage."

But even though heterochromatin has now been firmly implicated in chromosome pairing for achiasmate disjunction, many questions remain. One is just how the heterochromatin draws the chromosomes together. It may do so directly, if similar sequences on the two chromosome partners pair up, or indirectly, via proteins that bind to the heterochromatin DNA on both chromosomes and then to each other. Also unclear is whether heterochromatin plays a role in normal disjunction, in which recombination occurs.

And then there is the big question of whether the *Drosophila* results will reveal anything about meiosis in higher animals, including humans. No one knows whether chromosomes in these organisms undergo achiasmate disjunction, says Case Western's Hassold. Still, he notes, it is "not unreasonable" to expect that they might. He points out, for example, that some of the chromosomal abnormalities seen in *Drosophila nod* mutants, which disrupt achiasmate disjunction, resemble the chromosomal abnormalities that can arise when human meiosis goes awry. If achiasmate disjunction does occur in higher animals, then fruit flies, like birds and bees, may have plenty to say about the basics of human reproduction.

–Jean Marx

OPTICS

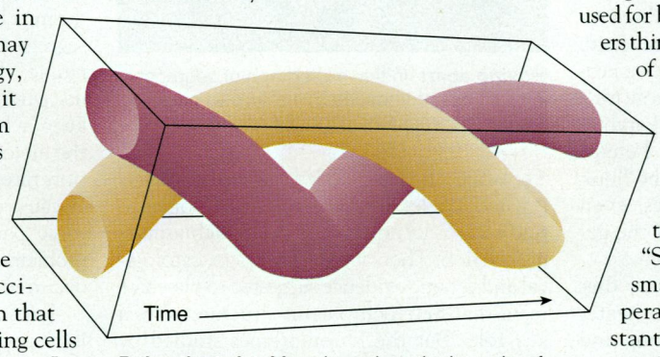
Helical Beams Give Particles a Whirl

For the past 25 years, physicists wanting to pick up and hold particles as small as a single molecule have reached for the tweezers—the optical tweezers, that is. Consisting of finely focused laser beams, optical tweezers rely on the electric fields created by light to trap particles that are too small to manipulate mechanically. Now two teams of researchers, in the United Kingdom and in Australia, have found that by using specially sculpted laser beams they can do more than just hold a particle in place: They can make it spin, speed up and slow down its spinning, and even bring it to a stop and spin it the other way. Such dexterity, say the researchers, makes the device an entirely new tool—what the British group calls an optical spanner, or wrench.

Described this week at the International Quantum Electronics Conference in Sydney, Australia, the spanner may one day be useful in nanotechnology, say researchers who envision using it to build tiny machines or power them by rotating particular parts. What's more, the spanner can immobilize its targets with less intense beams than optical tweezers use. Less intensity means less heating of the target, and—through a fortuitous accident—the British team has shown that the spanner may be able to hold living cells without killing them. If so, says biologist Justin Molloy of Britain's University of York, the spanner's gentler touch "could enable new classes of experiments to be performed using monomeric proteins."

Optical tweezers use the electric field created at the narrowest point of a tightly focused laser beam to hold onto particles of dielectric, or insulating, materials—which include most biological samples. The particles are electrically attracted to the region where the field, and the beam, is strongest: right at the center.

But Miles Paget and his colleagues at St. Andrew's University in Scotland and, working independently, Halina Rubinsztein-Dunlop's group at the University of Queensland in Australia suspected that a laser beam with a different intensity profile, known as Laguerre-Gaussian, might create a more versatile kind of trap. Such laser beams are doughnut-shaped in cross section, with a dark spot in the middle surrounded by a bright ring of laser power, and are created by shaping the beam with cylindrical lenses or holograms. Like an optical tweezers, a Laguerre-Gaussian beam draws a specimen toward its most intense regions—which are found not at its center but in the bright ring. If the size of the specimen is roughly the same as the ring diameter, it gets pinned by its edges. Both groups managed to trap particles this way.



Doing the twist. Map shows how the intensity of a Laguerre-Gaussian beam changes with time.

But that is not all that Laguerre-Gaussian beams can do. In their simplest form, such beams have a spinning, helical electromagnetic field. St. Andrew's physicist Les Allen predicted in 1992 that these rotating beams could impart angular momentum to a trapped particle, making it spin. Both groups have now shown that Allen was correct. In a paper soon to appear in *Physical Review A*, the Queensland researchers describe how, by changing the optics and reversing the orientation of the Laguerre-Gaussian mode, they were able to speed up and slow down a trapped, rotating particle and reverse its direction.

Both teams also found that their technique required less beam power than a conventional optical tweezers setup does to immobilize a particle—just one third of the usual power, the St. Andrew's group reports in a paper that will soon be published in the *Journal of Modern Optics*. This has important implications for biological samples, some of which are "opticuted" by the beam of conventional optical tweezers. Although they have yet to do a structured experiment, Neil Simpson of the St. Andrew's team says that they carried out an accidental one when one of their samples became contaminated with living cells. The researchers are not sure exactly what kind of cell ended up trapped in their beam, but it seems to have survived the experience. Although optical tweezers have already been used for biological experiments, the researchers think the spanner could extend the reach of these optical tools in this field.

Some biologists are not convinced that this promise will be realized, however. Molecular biologist Steven Block of Princeton University in New Jersey believes the beam will still damage samples. "Significant absorption of light by a small living particle leads to a temperature increase which may be too substantial to be consistent with biological experimentation," he says.

Proponents of nanotechnology have fewer reservations about the new tool. Peter Houzego of PA Consulting Group, a British technology R&D company, says it will find plenty of uses "when we start getting down to nanotechnology [and] we're going to need to be manipulating materials almost at the molecular level." When that day comes, engineers everywhere may want an optical spanner in their toolbox.

–Sunny Bains

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SOURCE: *PHYSICAL REVIEW LETTERS*, VOL. 75, NO. 5, 31 JULY 1995