A system of active optics that includes a wavefront sensor and a deformable mirror has been demonstrated to be an effective means of partly correcting wavefront aberrations introduced by fixed optics (lenses and mirrors) in telescopes. It is envisioned that after further development, active optics would be used to reduce wavefront aberrations of about one wave or less in telescopes having aperture diameters of the order of meters or tens of meters. Although this remaining amount of aberration would be considered excessive in scientific applications in which diffraction-limited performance is required, it would be acceptable for free-space optical-communication applications at wavelengths of the order of 1 µm.

To prevent misunderstanding, it is important to state the following:

- The technological discipline of active optics, in which the primary or secondary mirror of a telescope is directly and dynamically tilted, distorted, and/or otherwise varied to reduce wavefront aberrations, has existed for decades.
- The term "active optics" does not necessarily mean the same thing as does "adaptive optics," even though active optics and adaptive optics are related. The term "adaptive optics" is often used to refer to wavefront correction at speeds characterized by frequencies ranging up to between hundreds of hertz and several kilohertz — high enough to enable mitigation of adverse effects of fluctuations in atmospheric refraction upon propagation of light beams. The term "active optics" usually appears in reference to wavefront correction at significantly lower speeds, characterized by times ranging from about 1 second to as long as minutes.

Hence, the novelty of the present development lies, not in the basic concept of active or adaptive optics, but in the envisioned application of active optics in conjunction with a deformable mirror to achieve acceptably small wavefront errors in free-space optical communication systems that include multi-meter-diameter telescope mirrors that are relatively inexpensive because their surface figures are characterized.
Dual-Beam Atom Laser Driven by Spinor Dynamics

A Bose-Einstein condensate is adiabatically compressed to drive coherent spin-mixing evolution.

NASA’s Jet Propulsion Laboratory, Pasadena, California

An atom laser now undergoing development simultaneously generates two pulsed beams of correlated $^{87}\text{Rb}$ atoms. (An atom laser is a source of atoms in beams characterized by coherent matter waves, analogous to a conventional laser, which is a source of coherent light waves.) The pumping mechanism of this atom laser is based on spinor dynamics in a Bose-Einstein condensate. By virtue of the angular-momentum conserving collisions that generate the two beams, the number of atoms in one beam is correlated with the number of atoms in the other beam. Such correlations are intimately linked to entanglement and squeezing in atomic ensembles, and atom lasers like this one could be used in exploring related aspects of Bose-Einstein condensates, and as components of future sensors relying on atom interferometry.

In this atom-laser apparatus, a Bose-Einstein condensate of about $2 \times 10^6$ $^{87}\text{Rb}$ atoms at a temperature of about 120 μK is first formed through all-optical means in a relatively weak single-beam running-wave dipole trap that has been formed by focusing of a CO$_2$-laser beam. By a technique that is established in the art, the trap is loaded with a magnetic field). Then the intensity of the trapping laser beam is increased to drive coherent spin-mixing evolution: The increase in the intensity of the trapping laser beam adiabatically compresses the condensate to cause $^{87}\text{Rb}$ atoms to collide and thereby to undergo the angular-momentum-conserving reaction

$2(m_F = 0) \leftrightarrow (m_F = +1) + (m_F = -1)$.

As a result of this reaction, the original condensate becomes a superposition of (1) equal numbers of atoms in the $m_F = +1$ and $m_F = -1$ levels and (2) some