Major technical advance in astronomy improves diagnosis of eye diseases

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BLOOMINGTON, Ind. -- A major technical advance in astronomy is making it possible for scientists to see individual living cells of the human retina clearly for the first time. This will greatly improve doctors' ability to diagnose diseases of the retina such as glaucoma at an early stage, when intervention and treatment can prevent blindness.

A technology called adaptive optics allows astronomers to see distant stars with the ground-based Keck Telescopes in Hawaii almost as well as with the Hubble Space Telescope. Adaptive optics is a computerized system that continually measures optical flaws and then automatically corrects for them. It eliminates the distorting effects of Earth's turbulent atmosphere when astronomers are viewing objects in space with the Keck Telescopes.

Donald T. Miller and Larry Thibos, professors in the Visual Sciences Group at the Indiana University School of Optometry in Bloomington, are applying adaptive optics to the problem of eliminating the distorting effects of a patient's eye so they can examine the living cells of the retina at the back of the person's eye. Their high-quality instruments for examining the retina correspond to the astronomer's telescope; the cells of the retina correspond to stars in space; and the patient's eye corresponds to Earth's atmosphere since it is constantly changing, preventing images of the retina from becoming clearly focused for the examiner.

"The eye is a mediocre optical instrument compared with the tools that ophthalmologists and scientists have available," Thibos explained. "The eye is inferior because it is made out of biological materials, it grows, it is constantly changing and controlling its own growth, it has numerous flaws, and it gets worse as the person gets older."

Thibos has devised an instrument called an ocular aberrometer that measures optical aberrations in the eye by sensing errors in optical wavefronts reflected from the retina. Miller has developed technology that corrects those errors to obtain high-resolution images of the retina. "That's where the state of the art is right now," Thibos said.

Though their combined instrumentation is not yet in clinical practice, "It looks like there will be a large explosion of this in the next few years," Miller said. "Right now there are about five operational sytems in the world in laboratories, including here at IU."

When the equipment becomes available for clinics, a doctor will be able to get a clear view of individual cells in the retina and determine whether the cells are healthy or diseased, instead of having to wait for visible symptoms of retinal disease to appear. By the time symptoms become apparent, retinal cells often are dead and blindness may be unavoidable. If signs of retinal cell disease can be detected early, there is a much better chance of saving the patient's vision.

"In glaucoma, for example, the actual disease is cells in the optic nerve dying, and right now doctors can't see that happening," Thibos said. "They can only see it after the cells are dead. It may take 10 years for changes in vision caused by glaucoma to show up. They could do much better in treating glaucoma if diagnosis were early."

Age-related macular degeneration is another major application for this technology. "Scientists can now see retinal cells degenerating in the laboratory, but not in the patient's eye," Thibos said. "Early diagnosis would allow much superior treatment and prevention of blindness."

For more information, contact Thibos at 812-855-9842 or thibos@indiana.edu and Miller at 812-855-7613 or dtmiller@indiana.edu. Their research is funded by the National Eye Institute of the National Institutes of Health and by the National Science Foundation Center for Adaptive Optics.

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