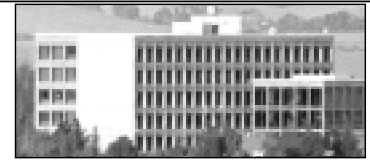

AROUND THE LAB

Search for planets yields shockwave breakthrough

By Anne M. Stark
NEWSLINE STAFF WRITER

It started as search for planets, but has expanded into a system that can be applied in the fields of broadband high-resolution spectroscopy and the precision angular measurements of stars.

The externally dispersed interferometer (EDI) uses a small and inexpensive interferometer with an external grating spectrograph for precision Doppler velocity measurements and high-resolution spectroscopy.

The idea started out as a 1998 Laboratory Directed Research and Development pilot project put together by physicist David Erskine, of the Physics and Advanced Technologies Directorate, using white-light velocity interferometry techniques from H Division's two-stage gas guns and combining it with astronomical spectroscopy.

The motion of a planet around a star causes a Doppler shift in the wavelength of the light. Light passing through the periodic fringes of an interferometer (and then into the spectrograph) creates a moiré pattern. The moiré pattern shifts transversely, proportional to the Doppler velocity. Spectrograph distortions can prevent a precision measurement of the Doppler shift, but by using the EDI, the small Doppler shifts of expolanets can be measured.

Erskine's group conducted bench-top testing in the Laboratory and then eventually tested it on starlight at the Lick Observatory in 1999. "This instrument truly helped reduce the distortion of starlight and is much easier to transport to any observatory," Erskine said.

While taking a year off for a sabbatical, Erskine worked on the theoretical aspect of the EDI and began to think of other applications for the device. Soon, he realized it could be used to boost the time resolution and stability of streak cameras recording high-speed phenomena, such as in shockwave physics experiments conducted at the National Ignition Facility. The time resolution boosting is analogous to a two-times spectral resolution boost he and his UC Berkeley collaborators have recently demonstrated at the Lick Observatory spectrograph.

David Erskine in front of the 10-meter-diameter South African Large Telescope (SALT) under construction. The telescope designers are interested in using Erskine's EDI technique to boost the performance of their spectrograph.

"The moiré effect is a heterodyning effect that shifts narrow details to become broad moire patterns," Erskine said. "These better survive the blurring of the spectrograph slit."

Using his custom software, the moire patterns can be analyzed to reverse the heterodyning and reconstruct the spectrum. "An analogous thing can be done in the time domain for NIF experiments," Erskine said. The spectral resolution boosting is described in the Aug. 1, 2003 issue of *Astrophysical Journal Letters*.

Working with a new LDRD that started Oct. 1, Erskine is intent on demonstrating a ten times resolution boosting effect, using a modified interferometer with multiple delays. Preliminary data he obtained in mid-October measuring the iodine spectrum indicated an eight-times resolution boost. He described his data and technique to a recent astronomy conference in South Africa where scientists there are interested in his method to boost the performance of a 10-meter telescope facility under construction, the Southern African Large Telescope (SALT).

He said in addition to the Doppler planet search, EDI applications include:

- High-resolution spectroscopy over a broad bandwidth with an unusually compact instrument.
- Boosting the resolution and stability performance of existing spectrograph facilities, in a simple retrofittable manner. "Like a pair of eyeglasses," he said, "we can inexpensively improve the performance of any type of grating spectrograph if one is willing to do some post-processing."
- Exoplanet search using stellar angular positions. Precision measurement of angular differences using a long baseline interferometer that is unusually insensitive to mechanical/optical drifts and therefore lower in cost.
- Improved interferogram analysis software that can accept irregular and unknown phase steps typical of real-world measurements (mechanical vibrations, air convections, etc.).