Beyond Theory

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Premier UA professor

explores how matter

behaves like light

By Kyle Schliesman

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Pierre Meystre, a University of Arizona regents professor, may one day be on the list of Nobel prize winners for his work in the still young field of atom optics.

"There have been several Nobel prizes given in this general field and the work that Pierre is doing is part of the development of that field," said Richard Powell, vice president for research at the University. "Pierre is probably the premier theoretical researcher in atom optics in the world today."

Already some of Meystre's theories have been proven in the laboratory. Powell calls this a rare instance of theory leading experimentation in the research world.

Mainly producing reports to explain atom optics theory, Meystre receives about $500,000 per year for his work from the National Science Foundation, the Army Research Office, the Office of Naval Research and NASA.

"He is working in a very futuristic, esoteric area of optics," said Kathleen Perkins, chief executive officer of Breault Research Organization, a Tucson-based optics firm. "He is doing groundbreaking work right here under our nose."

Meystre's work already earned him a Senior Distinguished U.S. Scientist Award from the Humboldt Foundation and the R.W. Wood Prize from the Optical Society of America. The latter was presented to Meystre last year for his contributions to several breakthroughs, including the "invention" of the field of nonlinear atom optics. The potential applications of this field are currently under examination.

"There are potential applications of atom optics which have come up and which we were not aware of when this new field started to emerge," Meystre said. "Basically, these applications have to do with the difference between light and atoms."

The basic difference is mass. Light is made up of photons, which are particles that have no mass, while matter is made up of atoms, which are particles that have mass. If atoms can be made to behave like photons, then those atoms could be used to add mass to devices which typically use light.

For example, gyroscopes which measure elements such as acceleration or other gravitational forces currently use lasers to take these measurements. However, the use of atomic wavelengths rather than photonic wavelengths might allow for more accurate measurements of force, since that force would have a greater impact on something with mass than something without mass, Meystre said.

Of course, potential applications for the research already are cropping up, he said. The military already has an interest in potential applications, such as the ability to measure sensitive gravitational changes which indicate changes in the density of matter undergroundin other words, devices which might locate underground facilities.

"There are lots of potential things which might come out of this in the future," Powell said. "The field is at the very forefront of science right now."

Atom optics has been around for about 20 years, but has roots going back to the 1920s, when French physicist Louis de Broglie theorized that atoms, like light, behave as waves of energy. While de Broglie eventually received a Nobel Prize for his theory, the discovered atom wavelengths were too small10,000 times smaller than the typical light waveto have any practical purpose.

However, scientists later discovered that, if atoms were cooled to low enough temperatures, the wavelengths could be extended to the size of typical light waves.

"In the last 16 or 20 years, people have really learned how to cool atomic systems to some incredibly low temperatures," Meystre said. "At this juncture, the wavelengths of the atoms become quite large. Suddenly you can do with atoms what you used to do with light. This is atom optics."

Meystre started his research in the area of quantum optics, which seeks to explain how light interacts with atoms. While this is a highly complex field, which led scientists to the development of the laser, Meystre eventually decided that he needed a greater challenge.

"The great fun of doing science is doing stuff you have no clue how to do," Meystre said. "Quantum optics was becoming kind of routine. I knew how to do it and I was getting bored with it, so I wanted a new challenge."

His new challenge is heading a research group that is part of a multi-disciplinary university research initiative.

The UA group of about a half-dozen researchers is collaborating with Havard, MIT and Stanford on atom optics studies. "We are kind of the theory component of this collaboration," Meystre said. "We have a reasonably large group. We are above critical mass, definitely."

Worldwide, 20 to 40 research groups are working on atom optics, Meystre said.

"The applications are pretty amazing," said Michael Stevenson, editor of OpticsReport, which recently profiled Meystre. Atom optics may result in a number of breakthroughs because it allows for the manipulation of atoms in the same way that traditional optics allows for the manipulation of light, Stevenson explained.

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