The use of laser beams to measure the size and concentration of solid particles in polluted air

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The use of laser beams to measure the size and concentration of solid particles in polluted air hundreds of feet - or even miles - away has been proposed by a research physicist at the University of California, San Diego.

In a presentation before the 1972 Annual Meeting of the Optical Society of America in San Francisco (October 19), Dr. Charles P. Wang, of UC-San Diego's Institute for Pure mid Applied Physical Sciences, reported he has demonstrated in laboratory experiments that lasers can be employed to measure the size of ultramicroscopic particles - liquid or solid - suspended In smog. The beams also can measure the number of such particles suspended in a given volume of polluted air.

One practical application of this finding, said Wang, would be to monitor pollutants being emitted by industrial plants. By aiming a laser at smoke coming from a factory stack, for example, the number of pollutant particles in the smoke, and their size, could be determined. Such readings could be obtained from a laser stationed hundreds of feet, or even miles, away from the smoke source, according to Wang.

Thus, an air-pollution control inspector could cruise through an Industrial sector, taking measurements with a laser in his vehicle. Or a high-powered laser could monitor a large area from a rooftop or tower.

This application of lasers is based on the theory of "optical mixing spectroscopy."

"The basic theory is simple," Wang explained. "It is known that when a light beam is scattered on striking a moving particle, its frequency becomes altered. This is called 'Doppler shift.' When the laser beam strikes the area under observation, 'optical mixing' results from the 'beating together' of various parts of the scattered light, and from the interaction of the scattered light with that of the laser. By measuring this 'optical mixing' effect, photodetectors linked to the laser can determine the size and concentration of the particles in a given area.

Based on the same theory, radar has been used to measure the size and distribution of snow crystals and raindrops, according to Wang. Searchlights also have been used to study particles in aerosol, or microscopic particles suspended in air, but only limited information was obtained because of the inherent deficiencies of such lights. Until the laser, the wavelengths of light reflected from such particles were too small to be detected.

The detection of pollution in the form of solid particles is important in terms of public health, said Wang, because it is known that certain microscopic particles may be inhaled into the lungs, accumulating there as deposits.

"Some particles are small that they dissolve on entering the human system," Wang explained. "Others are so large that they are excluded by the body, in the nasal passages for example, hence do not reach the lungs. But particles of a certain size do enter the lungs, and the detection of these particles in the atmosphere is essential for public-health purposes."

Wang's experiments at UC San Diego involved use of a 5-milliwatt laser beam in measuring milk particles suspended in water. Lasers used in measurements of polluted air would be perhaps one-hundred-thousand times as powerful, according to Wang. Such lasers are available, as are photodetectors which would be required in such measurements, he said.

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