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SWAMINOMICS
Raman Effect: fingerprinting the universe
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At school, we were taught that Sir CV Raman won the 1930 Nobel Prize for Physics for discovering the "Raman effect". But when we asked what exactly the Raman Effect was, our science teacher fobbed us off, saying "it's very complicated." Clearly, even he didn't know. Cynical students wondered why a complicated discovery without any obvious use had won the Nobel Prize.

But today, Raman's discovery has finally become a breakthrough technology. Hand-held scanners called Raman scanners, weighing just one-third of a kilo, are being used by US narcotics squads and airports to detect drugs. Security experts think that Raman scanners may be the best devices to detect explosives carried by terrorists. Safety inspectors are using Raman scanners to detect hazardous chemicals and gases. Police forces are using Raman scanners for forensic work.

The scanners work by detecting the molecular structure of the object they are scanning. If you shoot a beam of light on an object, a very small part of it interacts with the atoms of the object and scatters light in a pattern or spectrum unique to that particular molecule. This is the Raman Effect. It is difficult to detect, and typically needs lasers to amplify the signal. Every molecule has a different Raman pattern. This is why Raman scanning has been called the fingerprinting of the universe: it can identify substances as surely as fingerprints can identify humans.

Identifying the chemical composition of a substance typically requires chemical and physical tests that take time, maybe days. They typically require a sample to be extracted and destroyed while testing. But Raman scanning can take just 20 seconds. It does not require cutting, extracting or destroying a substance. Scanners have a laser, spectroscope and an electronic heart that can recognize Raman patterns. This yields almost instant recognition of target substances.

For instance, narcotics squads in the US are using Raman scanners programmed to detect up to 100 drugs. At the scene of a crime, or during airport security checks, the scanner can tell whether a substance is heroin, crack cocaine, amphetamine, or plain chalk. Security experts can programme scanners to detect different sorts of explosives such as RDX or nitroglycerine.

For decades, Raman's discovery could not be converted into easily usable or affordable tools. In his time, equipment for lasers and spectrum separation and scanning were primitive, bulky and costly. Only in the 1980s did laser technology progress to the point where it was compact and economic. This new technology was most popularly established in the CD player: a laser could scan a disc to play music.

Scientists in many fields, including space and telecom, began to research applications for the Raman Effect. Some found ways to enhance the Raman Effect by adding surface metals, making the effect easier to detect. This led ultimately to the invention of scanners that could detect trace elements of less than one part per billion. Such scanners can identify minute quantities of bacteria, chemical pollutants, or explosive elements.

A recent article in The Atlantic, a US monthly, says that Raman scanners are gradually becoming big business. It cites officials at Delta Nu, a manufacturer of Raman scanners, as saying that scanners are already a $150 million business, and growing fast. The company's scanners currently cost $15,000 each, but it hopes to cut the cost to just $5,000 in the next five to ten years.

Researchers at UCLA and Intel have incorporated the Raman Effect on silicon. Because of its crystalline structure, the Raman Effect is 10,000 times stronger in silicon than glass. Researchers at JPL and Caltech have found other ways to increase laser efficiency. This has driven down size and costs.

Researchers at Stanford University are experimenting with Raman scanners to diagnose cancers in various organs. River Diagnostics in Rotterdam is marketing a bacteria analyzer that hospitals can use to instantly detect deadly pathogens. One day, Raman scanners may make blood tests obsolete: a scan may suffice to tell you the content of glucose, cholesterol, uric acid and other elements in your blood.

Scientists aim ultimately to create a database of Raman patterns of every substance for easy identification. This is similar to NandanNilekani creating a national database for fingerprints and irises to identify every Indian. Databases have already been created for narcotics, pollutants and explosives, which is why scanners have already become practical tools. Every time they are used to catch a drug smuggler or terrorist, or to detect a cancer or pollutant, we can give thanks to CV Raman. School teachers can now teach students why exactly the Raman Effect is so important: it fingerprints the universe.