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Imaging and astronomy share new wave

Terahertz radiation spots DNA twinning and probes star formation.
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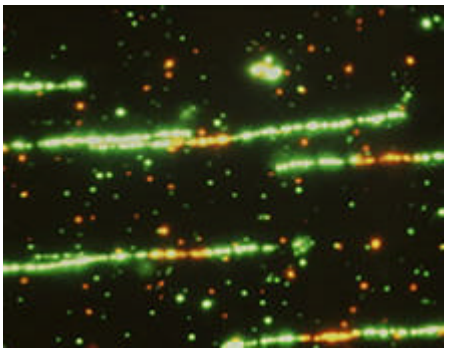
PHILIP BALL



Will gene chips soon be a no glow area?
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X-rays, ultrasound and fluorescent staining may soon give way to the next big wave in imaging technology: terahertz radiation. Having long languished in the neglected part of the spectrum where infrared meets microwaves, terahertz waves are now probing everything from cells to stars.

For example, Michael Nagel and colleagues at the Rheinisch-Westfälische Technische Hochschule in Aachen, Germany, have used terahertz radiation to spot particular sequences of DNA in a sample[1].

This technique is quicker and more accurate than current fluorescent-labelling methods. Affixing a fluorescent tag to a DNA molecule takes time and can subtly change its shape, and hence its behaviour.

Terahertz waves give Nagel's team a new take on gene chips. These chips, which detect genes in a tissue sample, house a forest of single-stranded DNA probe molecules. These are anchored to a support awaiting pairing with target strands in the sample.

Pairing occurs only if the sequences of molecular units in two strands are complementary. From the probe strands' sequences, one can deduce the sequences of those that pair with them - and thence the genes that those strands encode. Currently, scientists spot pair-ups by using fluorescent tags that glow under ultraviolet radiation.

Instead, Nagel's team identified paired DNA strands by looking for the characteristic terahertz-frequency vibrations

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of their backbones.

Terahertz resonances were different for samples containing fragments of the healthy and mutated gene

To detect changes in the tiny amounts of material that are typically involved in gene-chip analysis, the researchers built guide channels, just a few micrometres wide. These channels usher the terahertz signal to and from a patch of probe DNA. Comparing the signal before and after it passes through the DNA patch revealed the resonances that accompany pairing between probe molecules and their complementary strands in a sample.

To demonstrate the sensitivity of the technique, Nagel's team looked for binding between probe strands and target strands encoding a gene that is implicated in the disease hemochromatosis. In this condition, the body takes up excessive amounts of iron. It is caused by a single mutation in the gene - one wrong molecular unit among many.

Terahertz resonances were different for samples containing fragments of the healthy and mutated gene, reflecting the difference in binding to the probe strands.

Terahertz radiation seems set to find much wider application in biomedical science. Very short pulses of terahertz radiation can yield deeper images of damaged tissues (such as cancers and skin burns) faster and in more detail than can X-rays or ultrasound, according to researchers at the Rensselaer Polytechnic Institute in Troy, New York.

References

1. Nagel, M. et al. Integrated THz technology for label-free genetic diagnostics. ***Applied Physics Letters*****, 80**, 154 - 156, (2002).