High-speed and high-resolution dual-comb spectroscopy by combining two types of optical frequency combs

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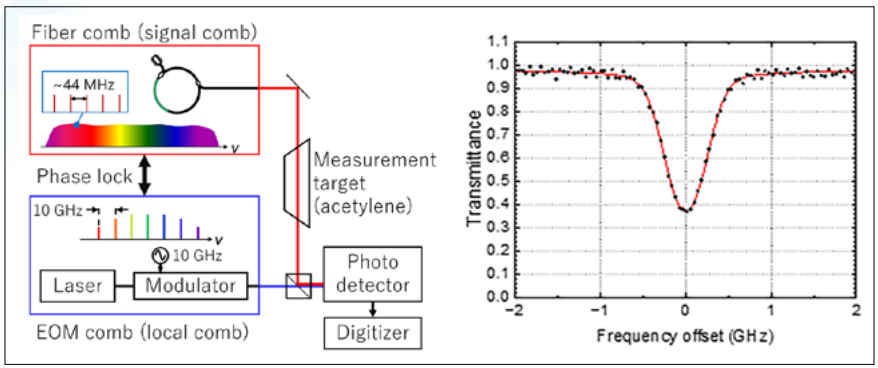
Optical frequency combs have equally spaced optical frequency modes and we can stabilize all mode frequencies by controlling frequency offsets and spacings. Dual-comb spectroscopy (DCS) is a spectroscopic method that uses optical frequency combs. One comb (signal comb) is absorbed by measurement targets such as gas phase molecules, and the other comb (local comb) resolves the absorption spectrum in high frequency resolutions. This does not require mechanical moving parts, and provides high measurement speeds and stable spectroscopy while the frequency resolution and the measurement speed are in a tradeoff relationship.

We realized a high-resolution DCS with higher measurement speed by combining two types of optical frequency combs with different generation principles: a fiber comb, which is based on a pulsed fiber laser with a narrow mode spacing, is absorbed by measurement targets, and an electro-optic modulator (EOM) comb, which is generated by modulating a single frequency laser output and has a high repetition frequency, reads out the absorption spectrum. We achieved a read-out speed increase of two orders of magnitude over the conventional method. The center frequencies of measured absorption lines in $\nu_1 + \nu_3$ band of acetylene ($^{13}C_2H_2$) molecule matched the previously reported values.



Experimental setup for high-speed and high-resolution dual-comb spectroscopy and a measured absorption line example in $\nu_1 + \nu_3$ band of acetylene ($^{13}C_2H_2$) molecule

Reference:
K. Kashiwagi, S. Okubo, and H. Inaba, *Opt. Express* **34**, 8262-8274, 2026
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