Integrated Dispersion Calculation

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→ Ultra-efficient freq comb in AlGaAs-on-insulator microresonators — Bowers

In a microresonator, the resonance frequencies ω_μ of the modes can be expanded in a Taylor series as:

$$\omega_\mu = \omega_0 + \mu D_1 + \frac{1}{2}\mu^2 D_2 + \ldots$$

$\frac{D_1}{2\pi}$ refers to the FSR around ω_0 and D_2 is related to the GVD (β_2) by

$$D_2 = -\frac{c}{n} D_1^2 \beta_2$$

Calculation of integrated dispersion

Say we have data with mode numbers & their corresponding frequency. We start by calculating the FSR as:

$$FSR_m = \frac{1}{2}\left(f_{m+1} - f_{m-1}\right) \qquad \text{(note that } D_1 = 2\pi \times FSR_0\text{)}$$

Now, we calculate 'μ_0' which is the mode-number of the mode whose frequency most closely matches the ~~mean frequency.~~ FSR_0 is the corresponding FSR.

If the mode strengths $|\mu_m|^2$ are known, the mean frequency can be calculated as:

$$\bar{f} = \frac{\sum_m f_m |\mu_m|^2}{\sum_m |\mu_m|^2}$$

Once μ_0 is calculated, we calculate relative frequencies & relative mode numbers as:

$$\omega_{rel} = 2\pi\left(f - f_{\mu_0}\right)$$

$$\mu_{rel} = m - \mu_0$$

Now we can calculate the integrated dispersion as:

$$D_{int} = \frac{\left(\omega_{rel} - \mu_{rel} D_1\right)}{2\pi}$$

where $D_1 = 2\pi\, FSR_0$