Wavelength Conversion with Nonlinear Optics

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Since its invention nearly 50 years ago (Maiman, 1960), the *laser* has become an indispensable optical tool capable of transforming *light* from its naturally *incoherent* state to a highly *coherent* state in space and time. The impact of this *optical coherence transformer* on the field of *Optics* has been similar to that of the *transistor* on the field of *Electronics*. At the same time, due to fundamental limitations, operation of the laser remains confined to restricted wavelength regions, making the laser a somewhat *spectrally inflexible* light source for many applications.

Nonlinear optics can overcome this limitation by converting the wavelength of existing lasers to new spectral regions using suitable optical crystals. In particular, *optical parametric generation, amplification, and oscillation* are versatile techniques that can produce coherent light with unique spectral and temporal flexibility from the ultraviolet to the far-infrared and in all time-scales from the *continuous-wave* to the *ultrafast femtosecond* regime.

This lecture will provide an overview of the basic principles of nonlinear optics for wavelength conversion, with emphasis on parametric processes, especially *optical parametric oscillators* (*OPO*s). The lecture will also provide a snapshot of the fundamental differences between lasers and nonlinear optical techniques, the latest technological developments, and applications of OPO sources in science and technology.