

## IMPRS UFAST core course

# Non-linear optics

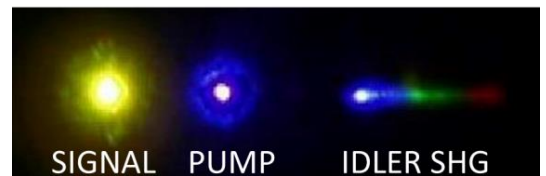
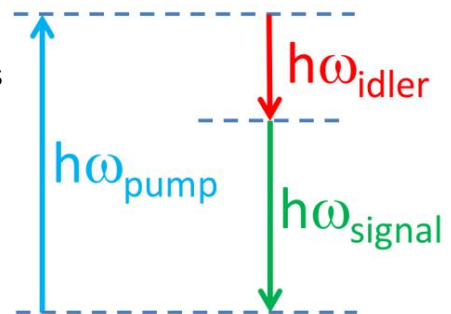
### Giovanni Cirmi

#### Abstract:

Nonlinear optics (NLO) is one of the most fascinating fields of modern physics. It deals with light-matter interactions at extreme electro-magnetic field strengths. Such fields are today routinely available thanks to laser technology. NLO started with the observation of second harmonic generation from a ruby laser in 1961, just 1 year after the first laser was operated. It allows producing optical pulses with durations in the femtosecond (fs,  $10^{-15}$  s) and even attosecond (as,  $10^{-18}$  s) order. With such sources, one can observe chemical reactions, physical and biological phenomena in real time. I will give a short overview of NLO, discussing the main physical phenomena (second harmonic generation, optical parametric amplification, difference and sum frequency generation, white light generation, third harmonic generation, high harmonic generation...) and some of their applications, and conclude with the newest trends of research like coherent pulse synthesis.

#### Topics include:

- Maxwell's equations in linear and non linear optics
- Energy and momentum conservation (phase matching)
- Second, third order nonlinear phenomena and femtosecond pulse generation
- High harmonic generation and attosecond pulse generation
- Applications to ultrafast spectroscopy
- Coherent pulse synthesis of optical parametric amplifiers



#### Online course

31<sup>st</sup> Jan– 4<sup>th</sup> Feb 2022

10:00h – 13:00h

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