

# **Optical properties of correlated electron systems: basic theoretical aspects and optical sum rule.**

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I will first review the standard derivation of the basic formulas for the optical conductivity in a lattice system. After a short warm-up on the derivation of standard expressions, I will focus on the meaning of a conserving approximation and on the issue of the optical sum rule. Once established what should be the 'standard' behavior of a Fermi-liquid metal and BCS superconductor, I will discuss three remarkable examples of emerging systems where standard paradigms do not apply: cuprate-based superconductors, iron-based superconductors and graphene. As we shall see, either the existence of strong correlation or the presence of a complex multiband structure, or both, make the optical properties of these systems rather unusual.