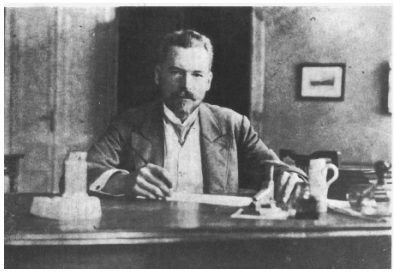

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Photoluminescence of Complex Systems

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The photoluminescence degradation of the thermally evaporated Alq3 thin films can be described by a four components model based on the Kohlrausch-Williams-Watt (KWW) function. This model improved the agreement between experimental data and the theoretical fit with respect to the four components model based on "pure" exponential functions. In fact, the negative bump in PL intensity decay observed in the reference not-annealed sample is perfectly fitted, and the last part of the time resolved spectroscopy improved its adherence to experimental data both in annealed and not-annealed samples.
A material frame of reference has been introduced in order to investigate the physical nature of the KWW function in relaxation processes and at the same time, explain the peculiar experimental features emerged in the time-spectral PL behaviour. The introduction of a nonlinear time variable, named material clock or material time, overcomes the difficulties carried by the anomalous behaviour considering the process from a bare point of view: the relaxation behaves ideally whereas the material frame of reference is going to be stretched or compressed. This allows to model the PL degradation dynamics as a damped harmonic oscillator. Once the physics has been understood, it is possible to restore the laboratory frame of reference and define the reduced mass, a time-depending function that unlocks the physical meaning of the experimental peculiarities observed in the PL emission.
The results are framed in the context of physical-chemical reactions in order to emphasize how the KWW function is a sum of sub-processes. The physical meaning of these sub-processes can be related to internal and environmental agents interactions under defined physical conditions. These insights highlight the usefulness of the proper mathematical procedures and properties, such as the monotonicity and the complete monotonicity, for investigating the PL emission of this organometallic molecule. Moreover, this method is also promising for describing the photoluminescent processes of similar organic molecules both for basic research and optoelectronic applications.

Primary author: LATTANZI, Ambra (Institute of Nuclear Physics IFJ-PAN, Krakòw, Poland - ENEA FSN-FUSPHYS-TSM, Frascati (Rome), Italy)

Co-authors: Prof. DATTOLI, Giuseppe (ENEA FSN-FUSPHYS-TSM, Frascati (Rome), Italy); Prof. BALDACCHINI, Giuseppe

Presenter: LATTANZI, Ambra (Institute of Nuclear Physics IFJ-PAN, Krakòw, Poland - ENEA FSN-FUSPHYS-TSM, Frascati (Rome), Italy)

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