Plenary Talk PV VII Tue 9:00 Audimax 2

Cuprous oxide: the ultimate material for studying excitons?

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Excitons determine the optical properties of semiconductors. They are currently attracting intense renewed interest due to their large binding energies in novel materials such as transition metal dichalkogenides. Excitons are typically described by the hydrogen model. The highest observed principal quantum number n has been five or less in almost any semiconductor. The only exception is cuprous oxide, Cu_2O, in which excitons were demonstrated for the first time in 1952. Recently, the combination of high resolution laser spectroscopy and high crystal quality allowed the extension of the exciton series up to n=28, showing also the exceptional position of cuprous oxide for studying exciton physics. This contribution discusses the status achieved in the assessment of excitons in Cu_2O: (i) About 60 quantum number combinations (n, orbital angular momentum L), defining different shells, have been observed spectroscopically, also by applying electric or magnetic fields. (ii) Not only the optically active states that are allowed in different orders of light-matter coupling, but also the optically forbidden states could be detected up to $n = 6$. (iii) In the fine structure of the excitons pronounced deviations from the hydrogen model are found, which arise from breaking of the rotational into discrete symmetries in the crystal. (iv) Due to the large size of excitons with high principal quantum numbers, pronounced interaction effects with other excitons are observed. A consequence is the Rydberg blockade, where the presence of one exciton blocks excitation of another one in its surrounding.