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# Polariton effects at $n = 1$ orthoexciton resonance in monoclinic β-$ZnP_2$ crystal

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Hydrogen-like *C* and *B* series in exciton spectra of β-$ZnP_2$ crystals have been first studied quantitatively under uniaxial compressive stress for several directions of wave vector and emission polarization states. The quantitative measurements of absorption spectra in *B* series at various temperatures and thicknesses of β-$ZnP_2$ samples have been first carried out. It is shown that all *B* spectrum lines form a single ortho-exciton series with *S* type enveloping functions. For the series members with $n \geq 3$, it is just low-energy components that are of S type. It is shown, that on the $B_{n=1}$ exciton resonance, the polariton effects are substantially pronounced and the Buger law is broken. The components of the oscillator strength tensor for transitions into $B_{n=1}$ exciton series have been determined.

Впервые проведены количественные исследования водородоподобных *C* и *B* серий в экситонных спектрах кристаллов β-$ZnP_2$ при одноосной деформации сжатия для различных направлений волнового вектора и состояний поляризации излучения. Впервые проведены количественные исследования спектров поглощения в *B* серии при различных температурах и толщинах образцов β-$ZnP_2$. Показано, что все линии *B* спектра составляют единую серию ортоэкситона с огибающими функциями *S* типа. Причем, для членов серии с $n \geq 3$ в дублетных линиях к *S* типу относятся низкоэнергетические компоненты. Показано, что на $B_{n=1}$ экситонном резонансе существенно проявляются поляритонные эффекты и нарушается закон Бугера. Определены компоненты тензора силы осциллятора для переходов в экситонные состояния *B* серии.

Light excitons, or excitonic polaritons, are absorbed in a crystal under dissipation of their mechanical energy characterized by decay parameter γ which takes place on the dissipative subsystem (phonons, crystal structure defects, and near the surface [1]). The fraction of the excitonic polariton electromagnetic energy or the strength of exciton-photon interaction is associated with the "lag" effect and defines the value of longitudinal-transverse split-off which is directly defined by the excitonic transition oscillator strength. The decay parameter γ can be smoothly changed by increasing the crystal temperature. At a certain temperature $T_c$ it reaches the critical value $\gamma \geq \gamma_c$, when the exciton-photon interaction becomes negligible and the crystal loses its spatial dispersion. This is confirmed by the transparency loss at $n = 1$ exciton resonances [2–6]. The area under the curve becomes therewith proportional to the excitonic transition oscillator strength *F* and independent of the sample temperature and thickness in accordance to the semi-classical [7] and quantum-statistical theory of excitonic absorption [8, 9].

In optical spectra of the low-symmetry monoclinic zinc diphosphide β-$ZnP_2$ crystals, at least two relatively weak dipole-forbidden *A* and *B* hydrogen-like exciton series are observed near the fundamental absorption band besides the well-known hydrogen-like *C* series of electrical-dipole singlet exciton and its mixed mode [10]. It is essential that the Rydberg constant $R_y$ is different for each series of exciton absorption lines, but all the series converge to a single limit