Electromagnetically-induced transparency via biexcitons in semiconductor quantum wells

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Nonlinear optical effects in atomic 3-level systems

- electromagnetically-induced transparency (EIT)
- lasing without inversion
- adiabatic population transfer
- ultraslow light

**Analogous coherence effects in semiconductors?**

- \( hh, \) \( lh \) valence band, conduction band (Arizona, Iowa, …)
- 3 conduction subband (London, …)
- \( hh \) valence band, 2 conduction subbands (Chicago, Texas, …)
- ground state, spin +/- excitons (Oregon, …)
- ground state, exciton, biexciton (Oregon, Arizona, …)
Interference up to 3rd order: excitons

\[ P = \Omega_+ \Omega^* \Omega_+ + \Omega^* \Omega\Omega^* \Omega_+ + \Omega^* \Omega\Omega^* \Omega_+ + \cdots \]

\[ T = \ \Omega^* \Omega\Omega^* \Omega_+ + \cdots \]

excitonic polarization
- Clear EIT dip in both experiment and theory, transmission increase by factor of 22 (13dB)
- Full recovery after control pulse gone (control duration 6 ps)

pump probe biexciton

\[ \omega \approx E_{\text{IT dip at}} \]

\[ \hbar \omega_{\text{pump}} + \hbar \omega_{\text{probe}} \approx \varepsilon_{\text{biexciton}} \]

shifts with increasing pump intensity (excitonic correlations beyond 3rd order)