



□ Background (Extreme nonlinear optics)

□ High-power THz-wave generation

□ Non-linear THz spectroscopy in solids

□ Perspectives

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### **B** Impurity ionization in Ge:Ga





### **THz-pump and visible-probe system**



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### **Exciton ionization in ZnSe MQWs**



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## THz induced luminescence





### <u>GaAs quantum wells</u>



• Non-doped

• Low temperature measurement (10 -150 K)

• The electric field is perpendicular to the stacking direction and along the (100) direction of the sample

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### Electric field dependence



- Luminescence centered around 1.55 eV.
- The number of carriers increases by about three orders of magnitude.



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According to optical-pump optical-probe measurement

- Carrier-carrier scattering : 2  $\sim$  10 fs
- $\cdot$  Optical phonon emission : 100 ~ 400 fs

**Near-infrared** transient absorption measurement with single cycle THz pulse excitation



## **THz-induced Transparency**



#### THz induced transparency over 14% at 800 nm

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### **Harace Theorem Theorem 1 Theorem 1 Theorem 1**



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## **Boltzmann equation**



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### **B** Near-field detection

- Probe light need to "read" THz waves before diffraction
- This spatiotemporal gating is obtained by using a thin EO crystal (10 µm-thick LiNbO<sub>3</sub>)

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# Rear-field image of metamaterial



*E<sub>THz</sub>* 200 kV/cm Photron 12 bits/ 500 FPS 34 averaged images 800 x 1000 pixels

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### B



- □ Single-cycle carrier-envelope phase locked THz pulse is ready with E > 1 MV/cm
- Intense THz wave with E > 1 MV/cm can induce significant nonlinear optical phenomena in solids.



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### Thank you for your attention !

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