Towards a Rydberg atom-based axion search: Identifying Rydberg states using EIT spectroscopy

YUQI ZHU, a postdoc in Reina's group

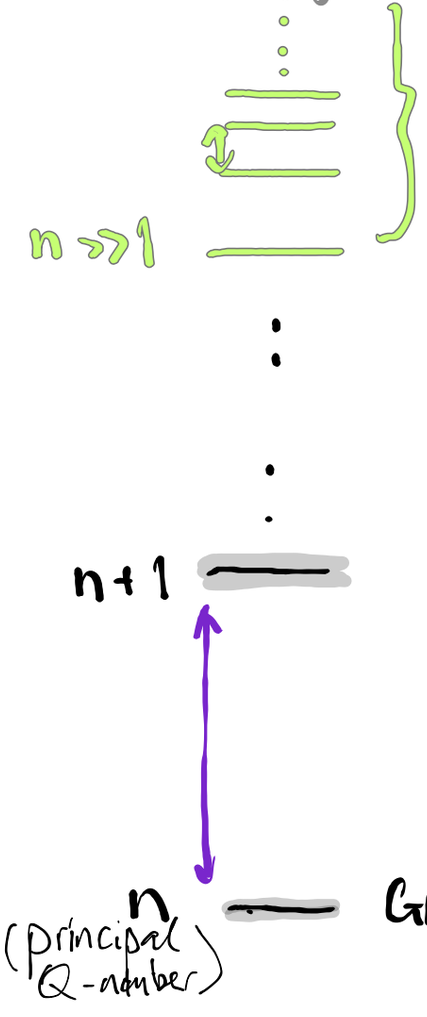
long-term goal : a Rydberg atom-based axion search

haloscope : axion $\xrightarrow[\text{B-field}]{\text{inverse Primakoff}}$ photon $\xleftrightarrow{\text{dipole}}$ Ry. atom
(MW, 10-100 GHz)

transition freq

MW
(~1-100 mm)

Energy levels



target
mass range
10-50 GHz ⟷ $n \sim 50\text{-}90$
39 K

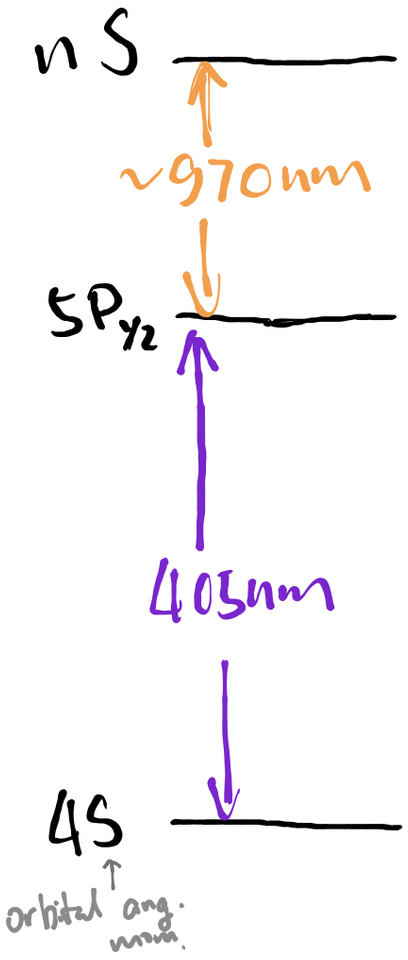
Johannes Rydberg's formula

$$\frac{1}{\lambda} = R_y\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

Credit : wiki

Project's goal: GWD → Rydberg?

two-photon transition



^{39}K
($n \sim 50-90$)
Sensitive to
10-50 GHz

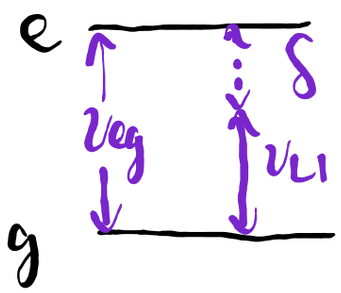
Challenge: 970-nm transitions

method: Spectroscopy based on EIT

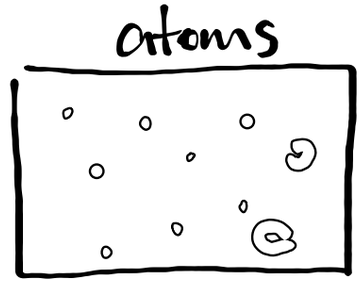
electromagnetically induced transparency

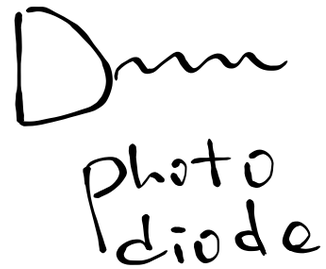
How does spectroscopy work?

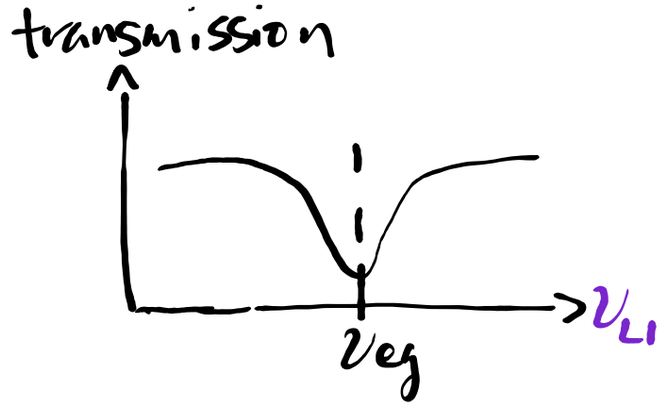
absorption

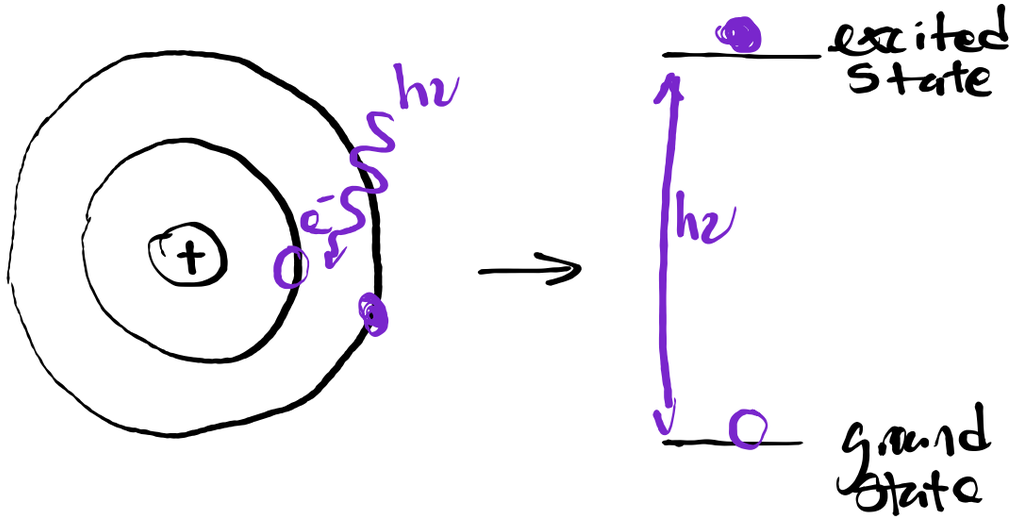


laser 1



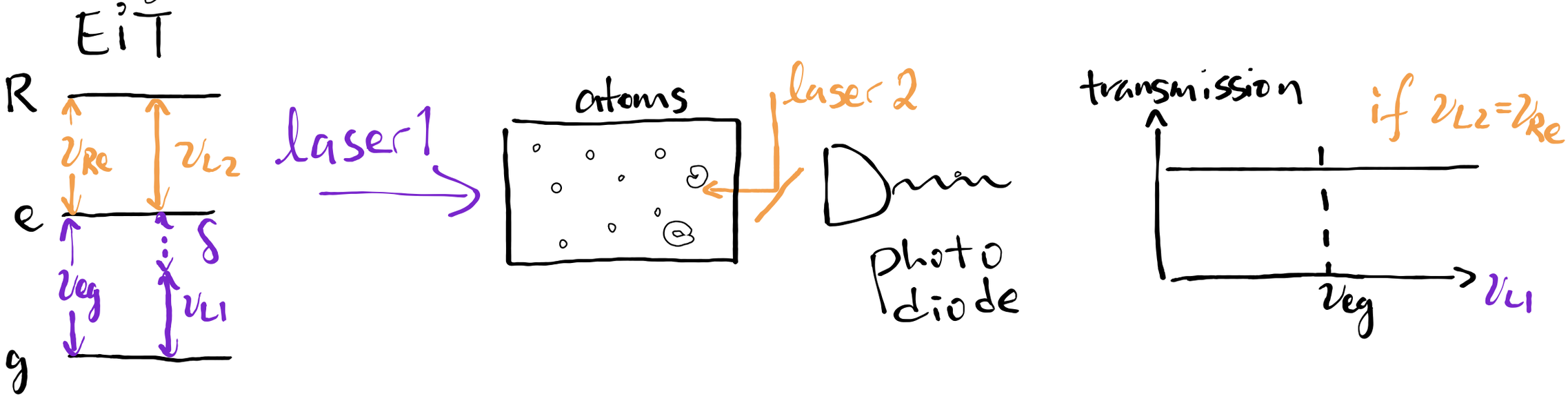




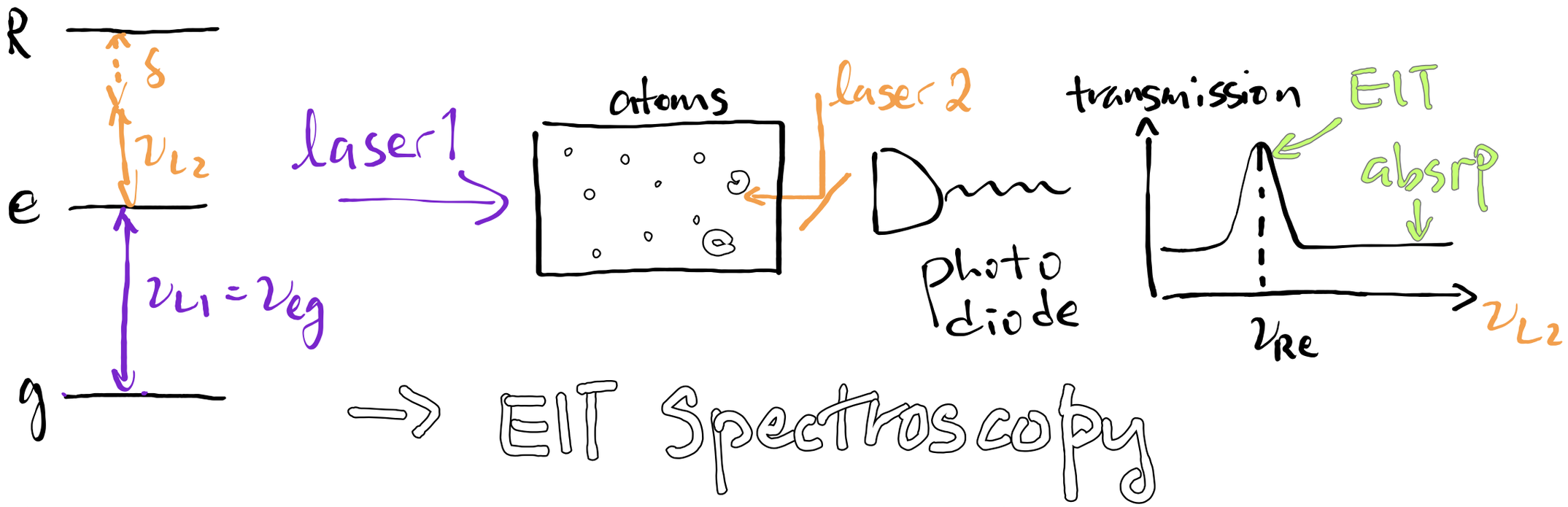


Bohr's model
(single valence e^-)

Why is it called electromagnetically induced transparency?



How to make use of EiT to find $\nu_{L2} \overset{!}{=} \nu_{Re}$?



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Results (& Reality) →