A Graph-Based Model Building Approach for Time-Resolved Ellipsometry

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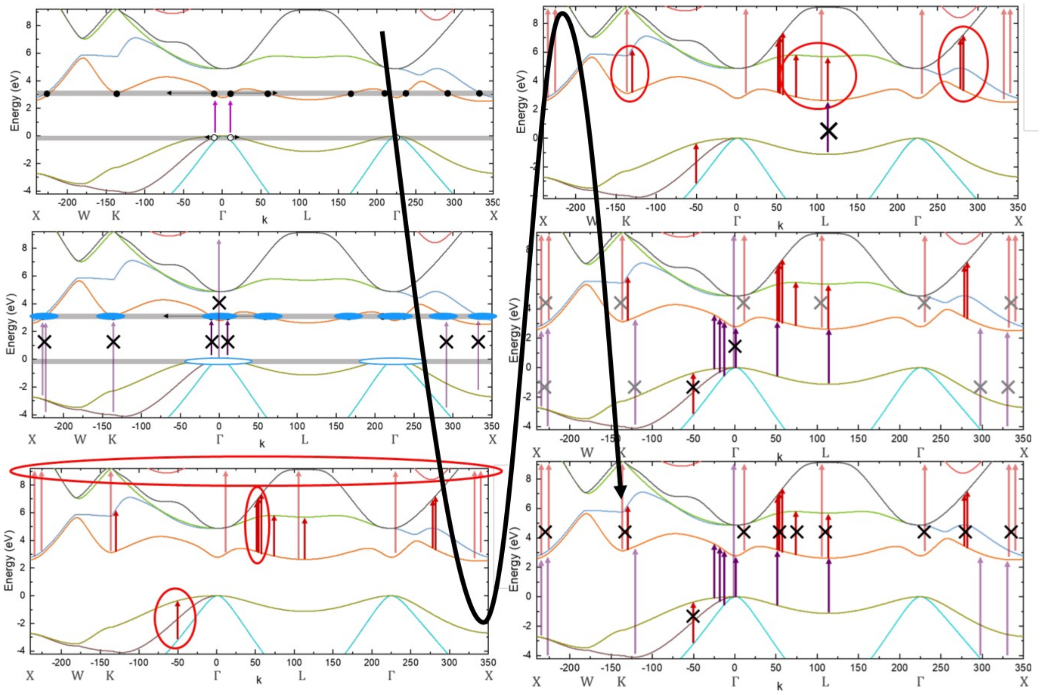
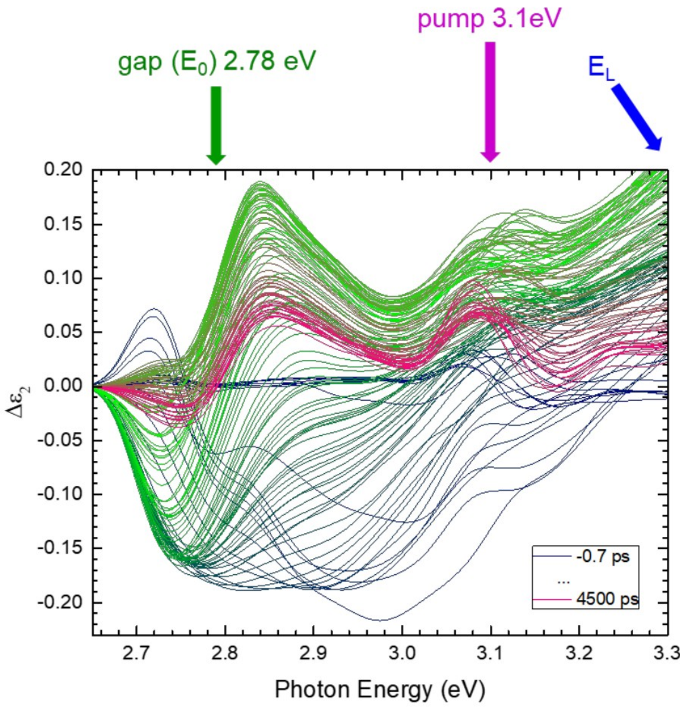
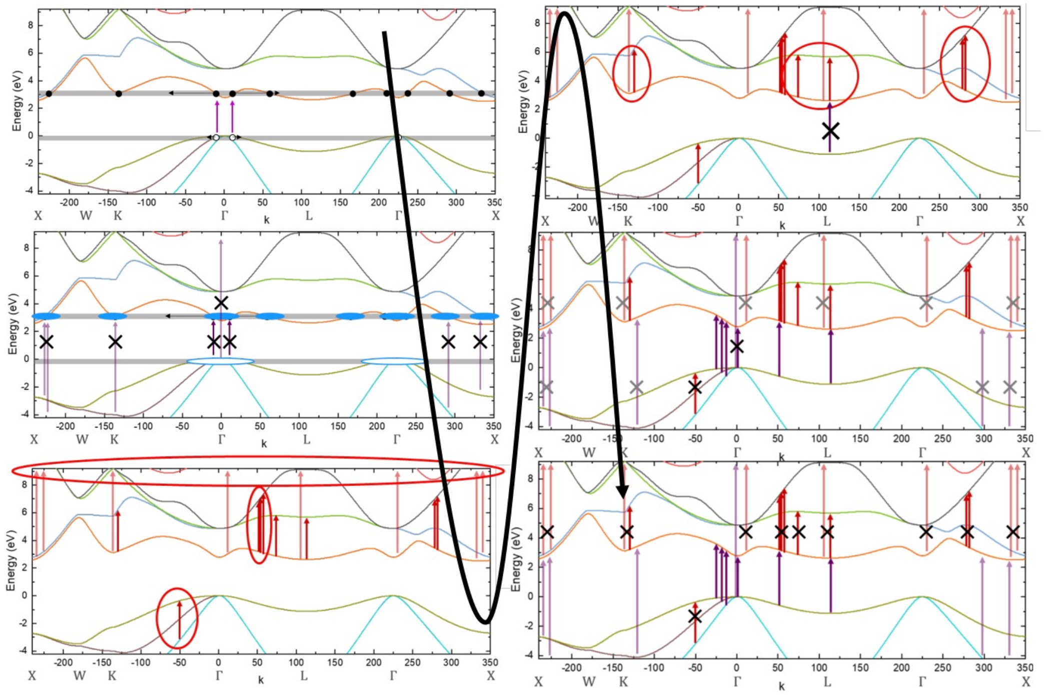
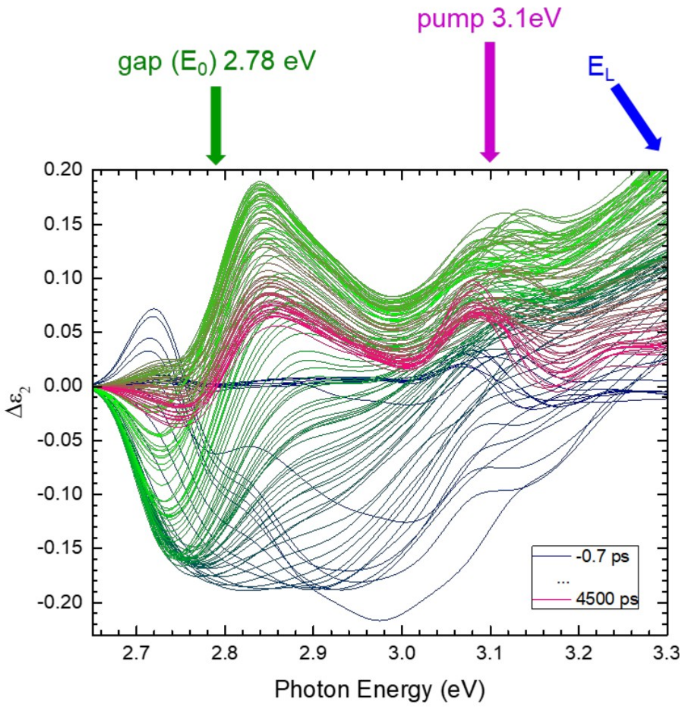

Energy (eV)
k
X W K Γ L Γ X

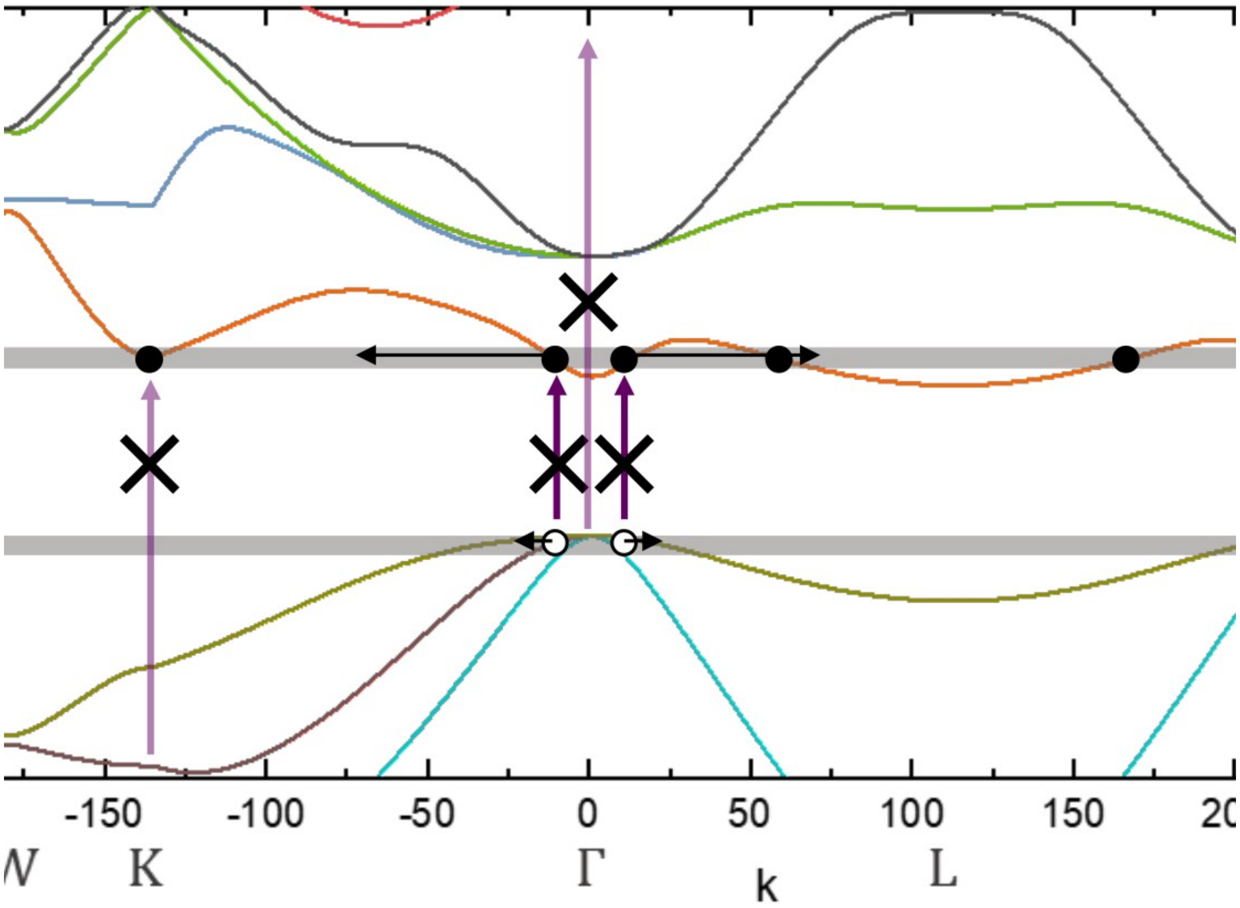

gap (E_0) 2.78 eV
pump 3.1eV
E_L
$\Delta\varepsilon_2$
Photon Energy (eV)
-0.7 ps
...
4500 ps

mental model

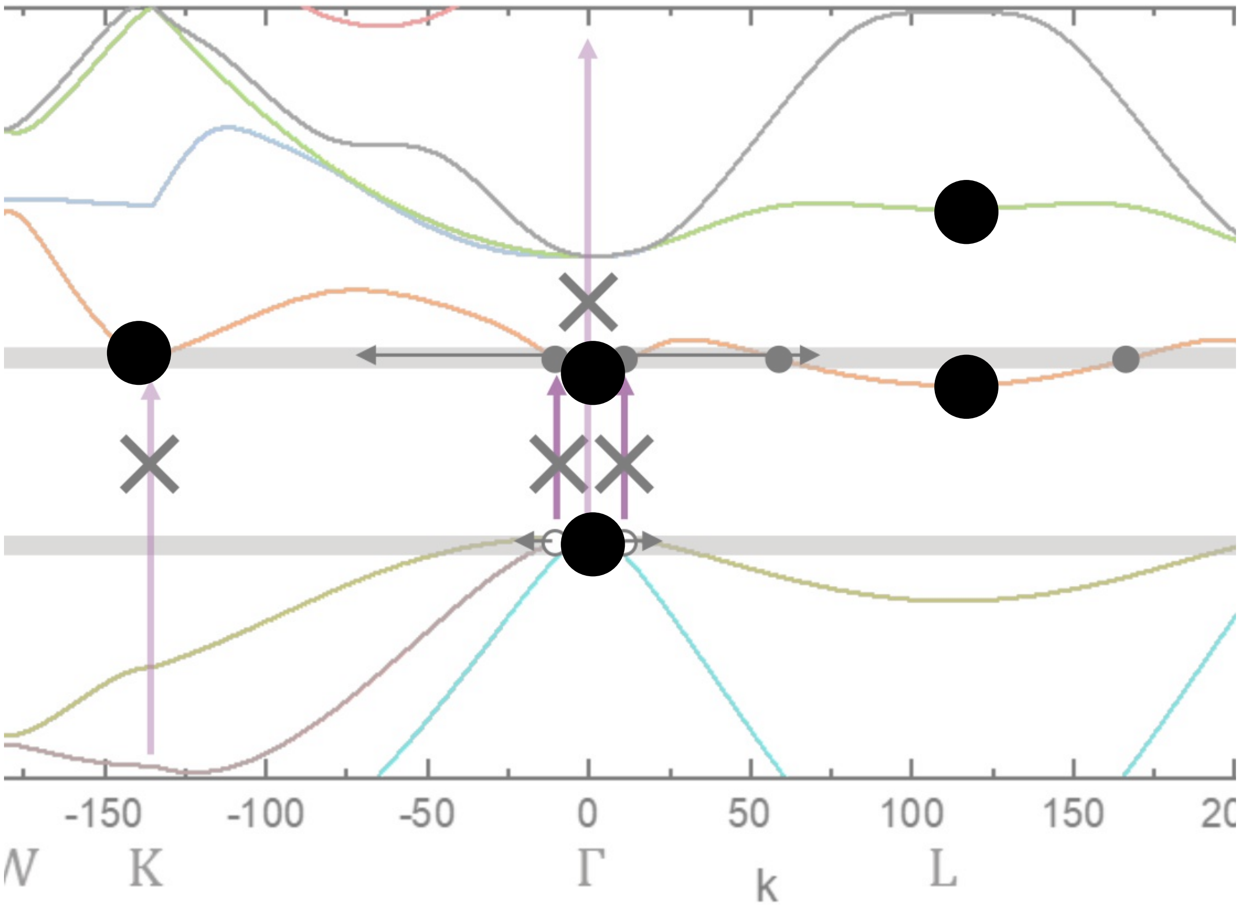
"steady state" model(s)







-150
-100
-50
0
50
100
150
20
W
K
Γ
k
L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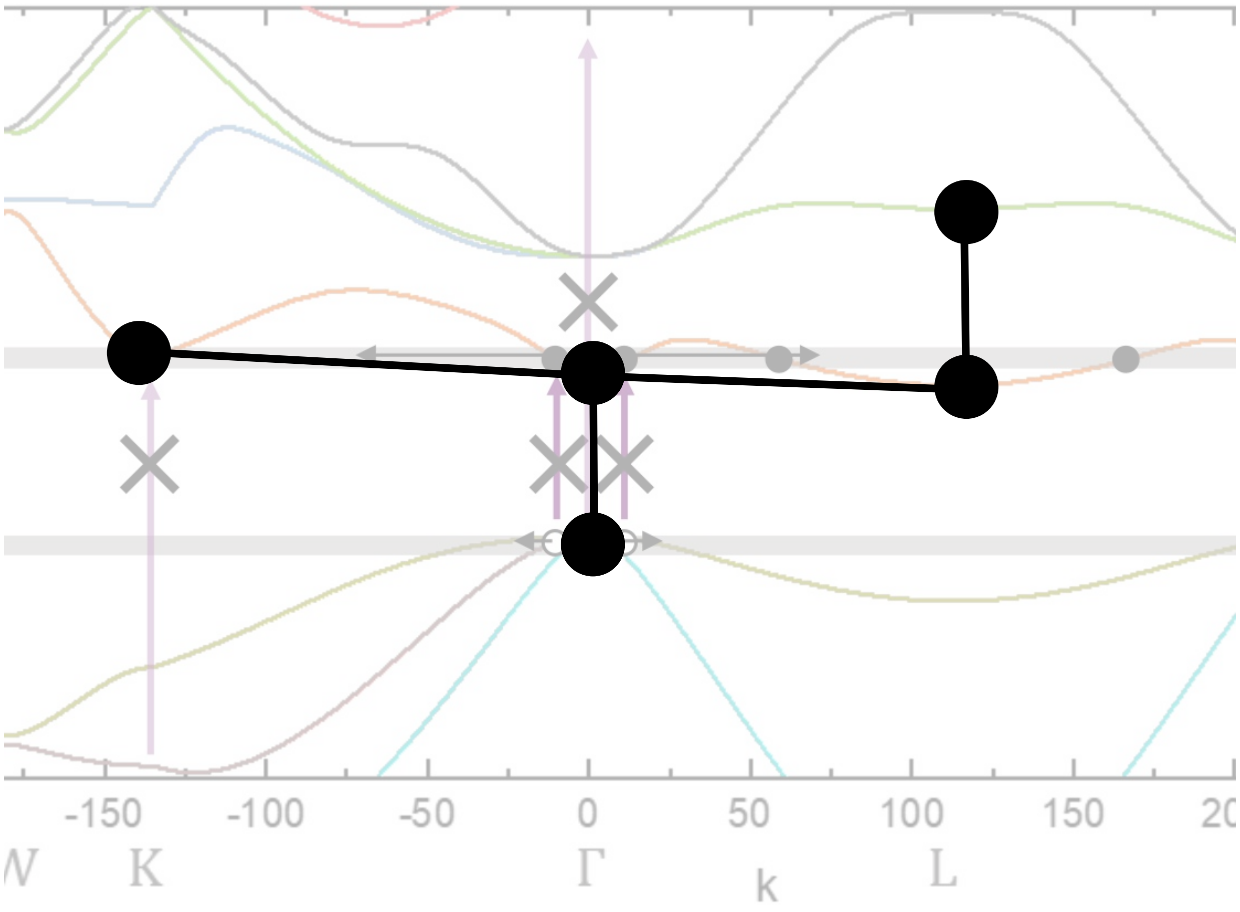
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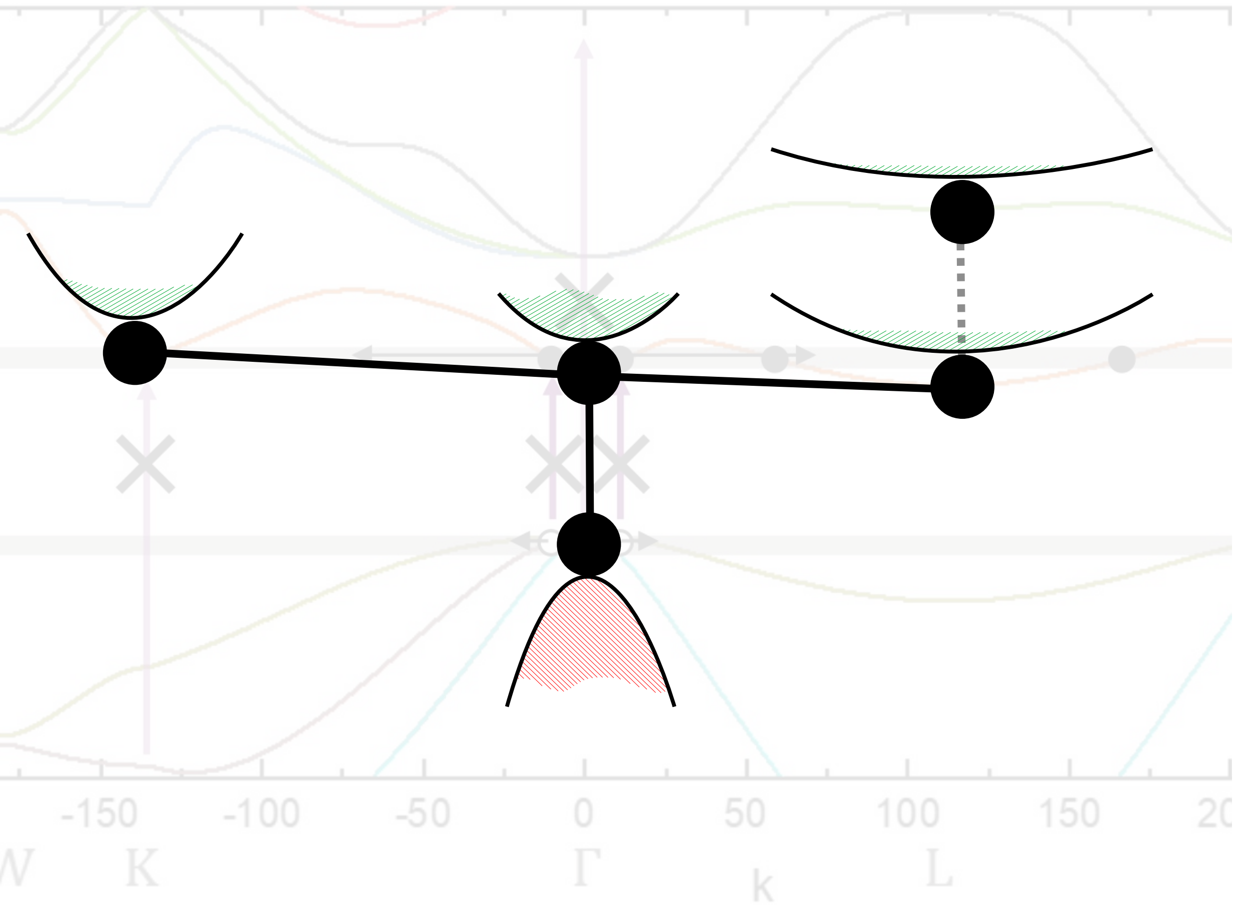

-150
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W
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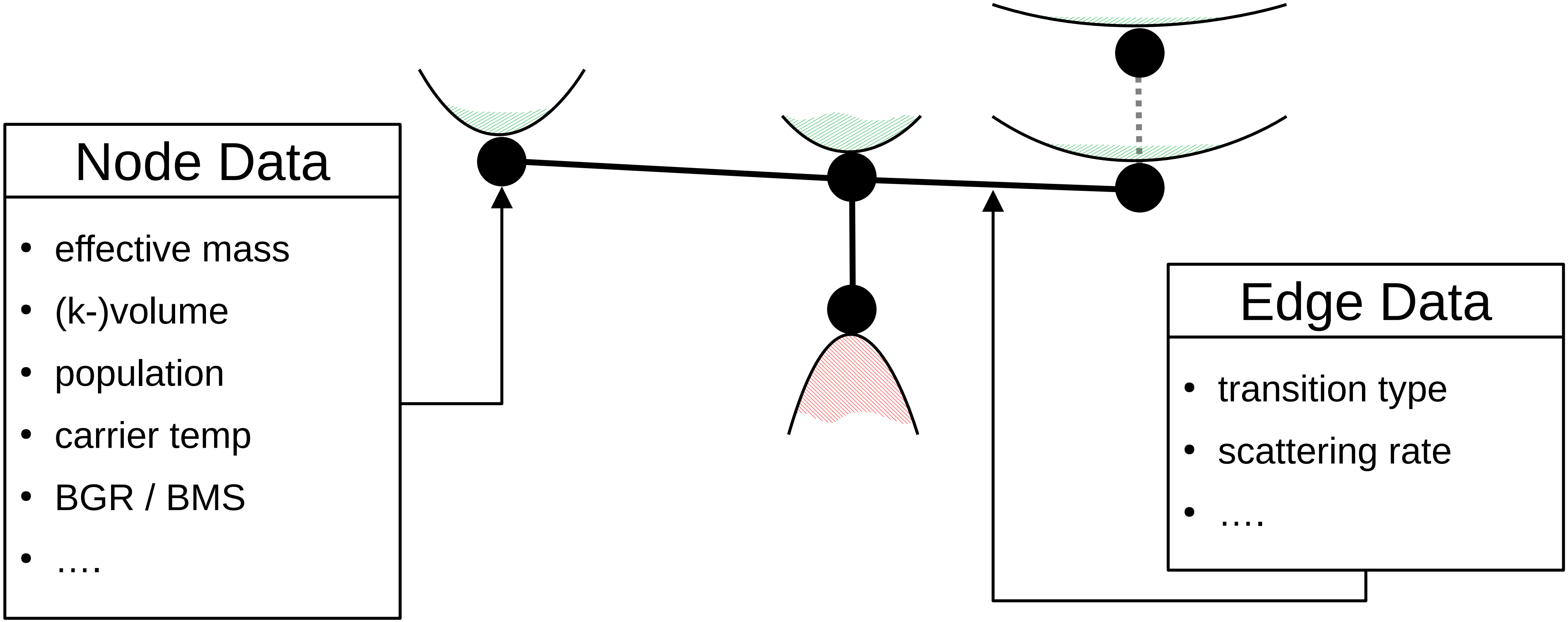

Node Data
effective mass
(k-)volume
population
carrier temp
BGR / BMS
….
Edge Data
transition type
scattering rate
….

$$\dot{n}_m = \sum_{i \to m} g(\Delta E_{i \to m}, t) \cdot \gamma_{i \to m} \cdot n_i (N_m - n_m) - \sum_{m \to f} g(\Delta E_{m \to f}, t) \cdot \gamma_{m \to f} \cdot n_m (N_f - n_f)$$

$$\dot{n}_m = \sum_{i\to m} g(\Delta E_{i\to m}, t)\cdot \gamma_{i\to m}\cdot n_i (N_m - n_m) - \sum_{m\to f} g(\Delta E_{m\to f}, t)\cdot \gamma_{m\to f}\cdot n_m (N_f - n_f)$$

$$\varepsilon(\omega) = \sum_k M_k(\omega; n_i, n_f\ [, \vec{p}(t)])$$

$$\dot{n}_m = \sum_{i\to m} g(\Delta E_{i\to m}, t)\cdot \gamma_{i\to m}\cdot n_i (N_m - n_m) - \sum_{m\to f} g(\Delta E_{m\to f}, t)\cdot \gamma_{m\to f}\cdot n_m (N_f - n_f)$$

$$\varepsilon(\omega) = \sum_k M_k(\omega; n_i, n_f\ [, \vec{p}(t)])$$

$$\dot{\varepsilon}(\omega) = \sum_k \frac{\partial M_k(\omega)}{\partial n_i}\dot{n}_i + \frac{\partial M_k(\omega)}{\partial n_f}\dot{n}_f \quad \left[+ \frac{\partial M_k(\omega)}{\partial \vec{p}}\dot{\vec{p}} \right]$$

Compatibility / Extensibility of the Model

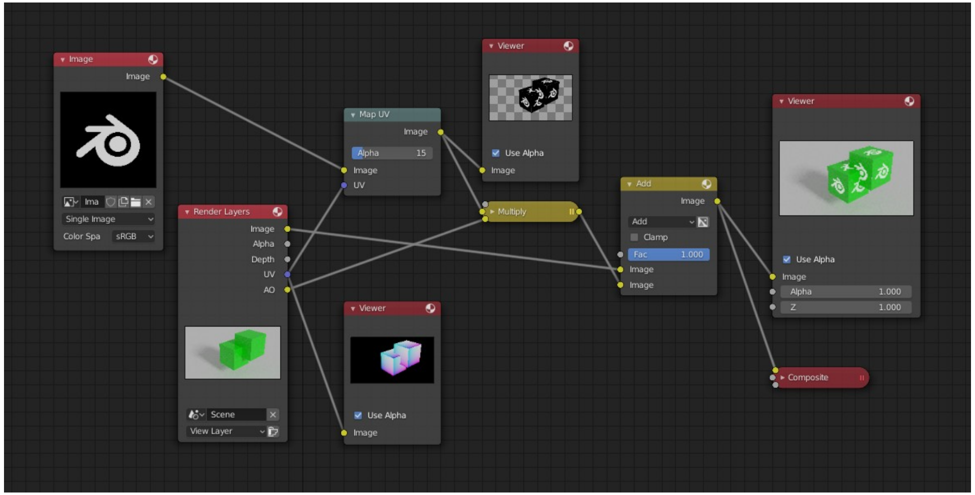
$$\dot{n} = \dots$$
$$\dot{\varepsilon} = \dots$$
$$\dot{T} = \dots$$
$$\dot{\Delta} = \dots$$
$$\vdots$$

- Extending the model to include more effects (approximately) is in principle straightforward
- Having the ODE system enables access to a large ecosystem of ODE analysis and parameter estimation tools (nonlinear optimization, particle swarm, Bayesian, neural nets, etc…)
- Including spatial diffusion is also possible at higher computational costs (solving one instance of the model for every mesh element in a finite elements / finite differences simulation

“Node Based” User Interface Design Philosophy

Do not forget to show the video here 😊

“Node Based” User Interface Design Philosophy



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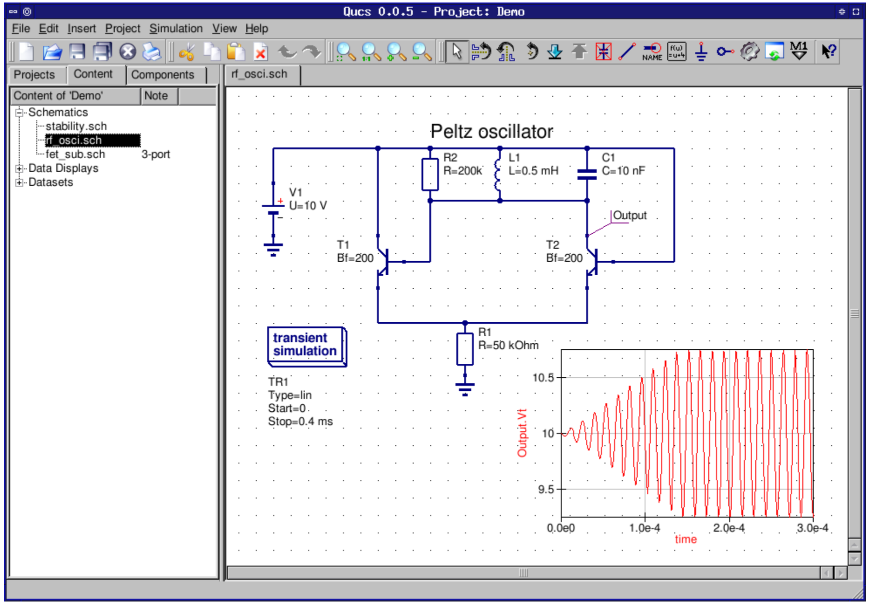

qucs.sourceforge.net

Conclusion

- A system of ODEs is a flexible description of TRSE measurements

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Thank you for your attention!