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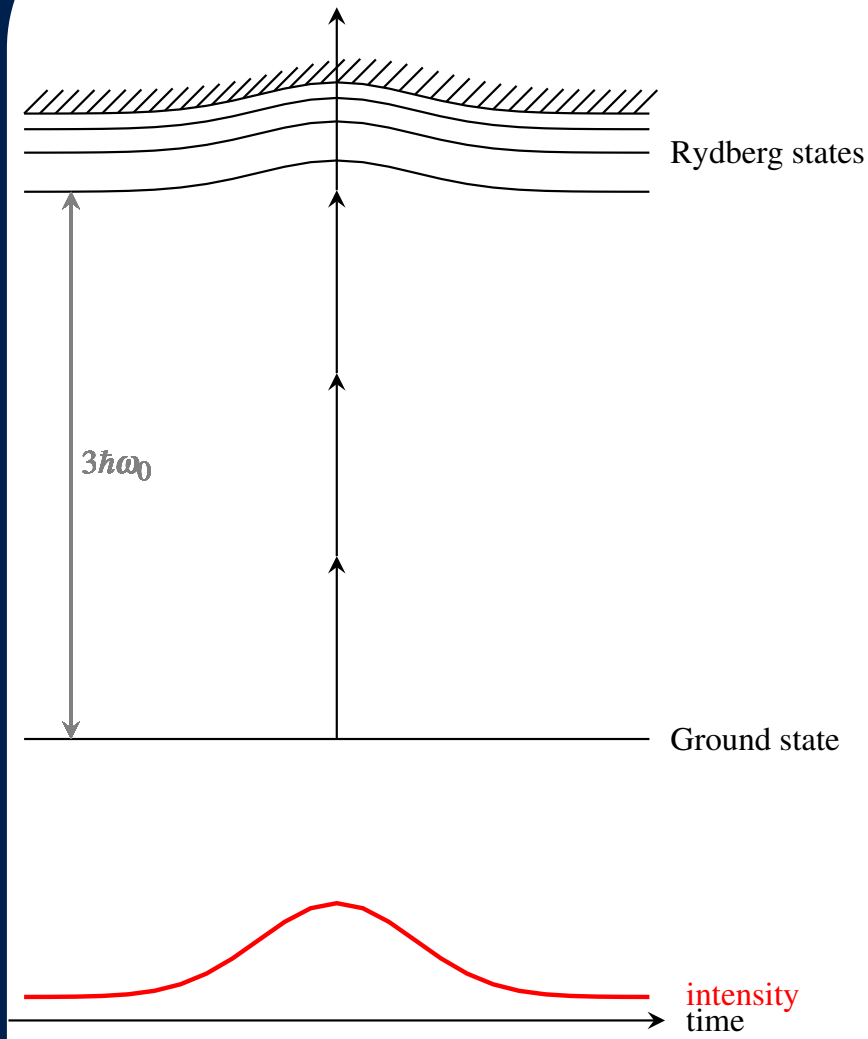
Institute of Condensed Matter and Nanosciences
Université Catholique de Louvain

Three-photon ionization of $He(1s2p\ ^3P^o)$ and $He(1s2s\ ^3S^e)$

– EGAS 46, Lille –

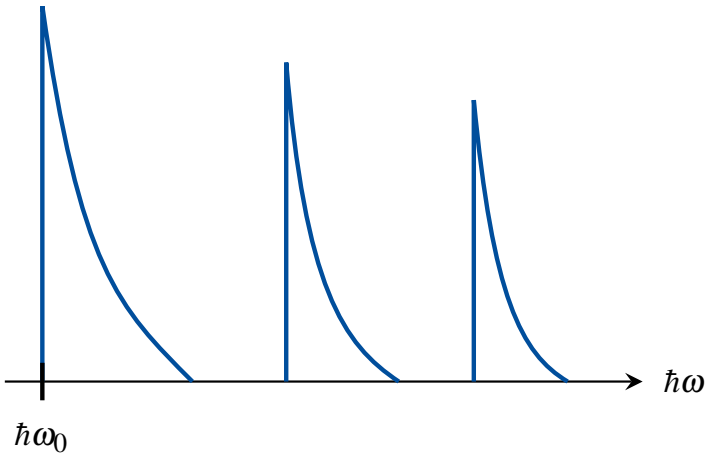
Multiphoton ionization : ground state



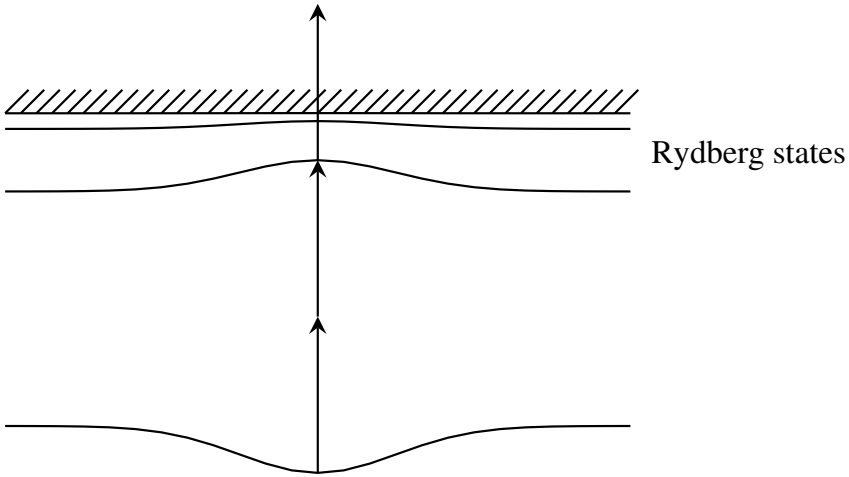
From the ground state :

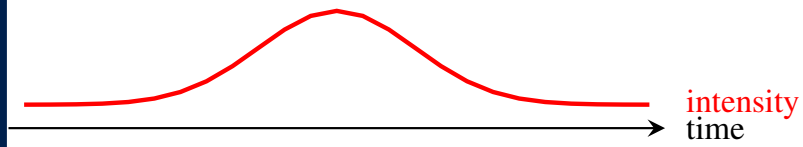
- Ponderomotive shift

Expected ionization spectrum :



Multiphoton ionization : excited state





From the ground state :

- Ponderomotive shift

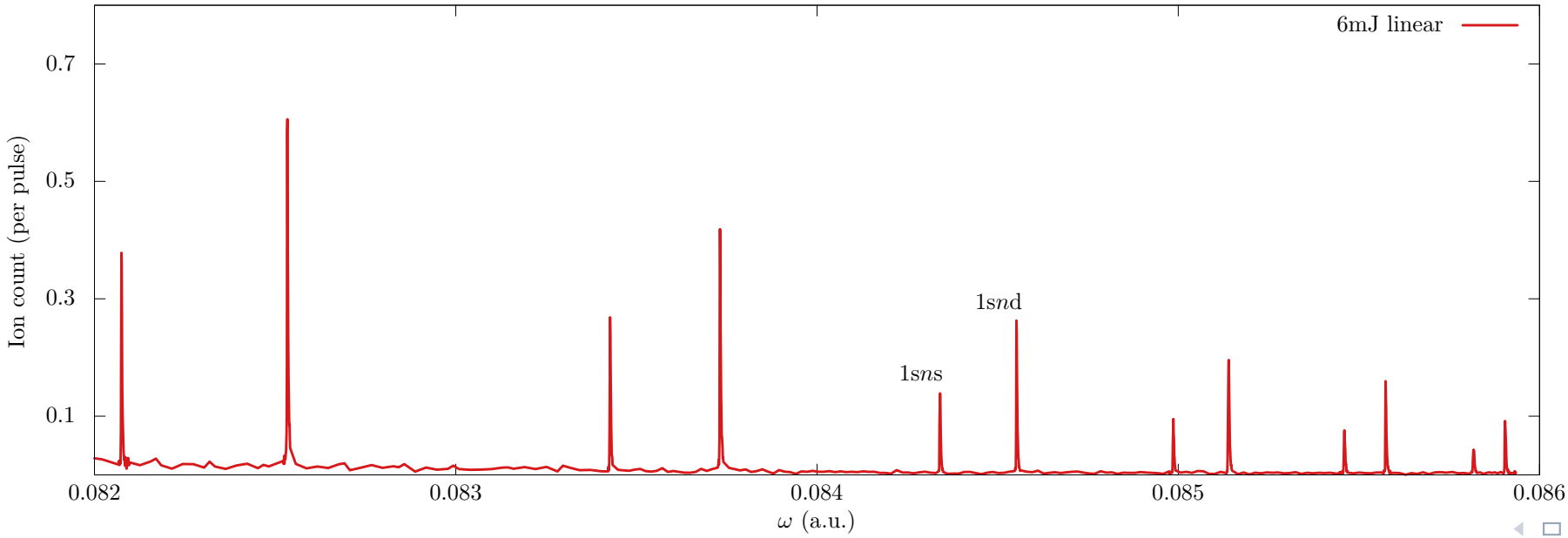
From the excited state :

- Dynamic Stark mixing

Expected ionization spectrum :

?

A simple case : the 1s2s ^{3}S state



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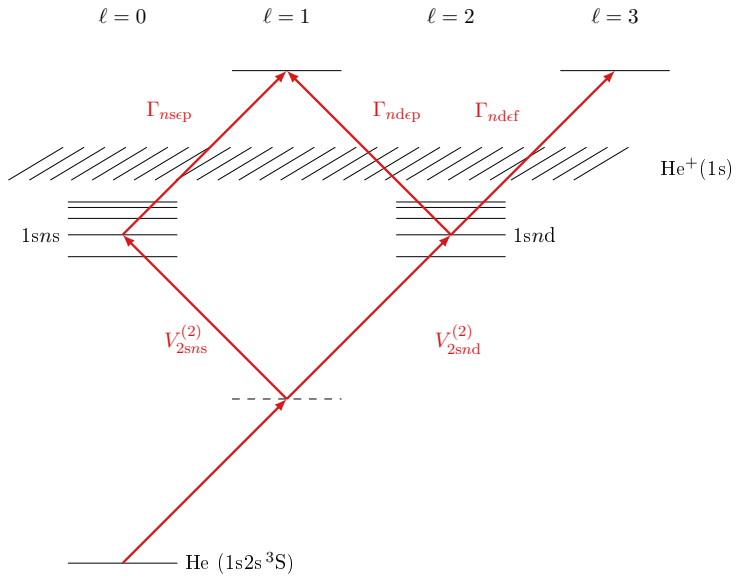
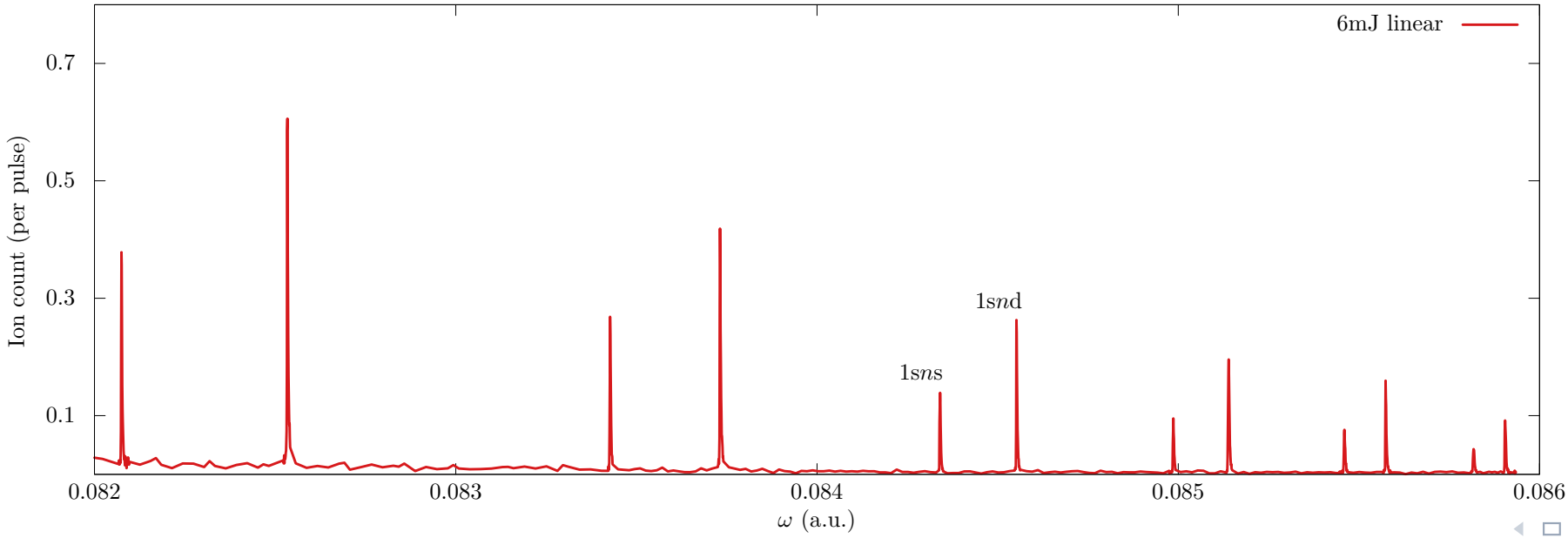
Characteristics :

- (2+1) REMPI
- 530-560 nm
- $I \simeq 3\times10^{10}$ W/cm^2





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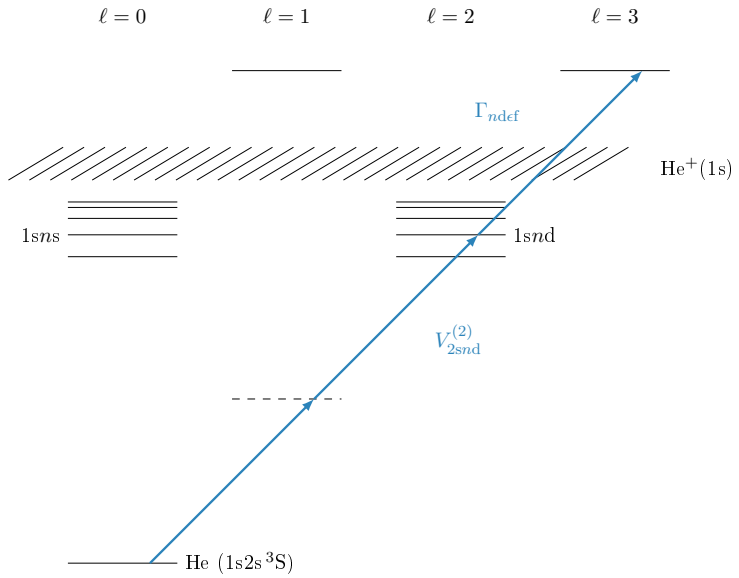

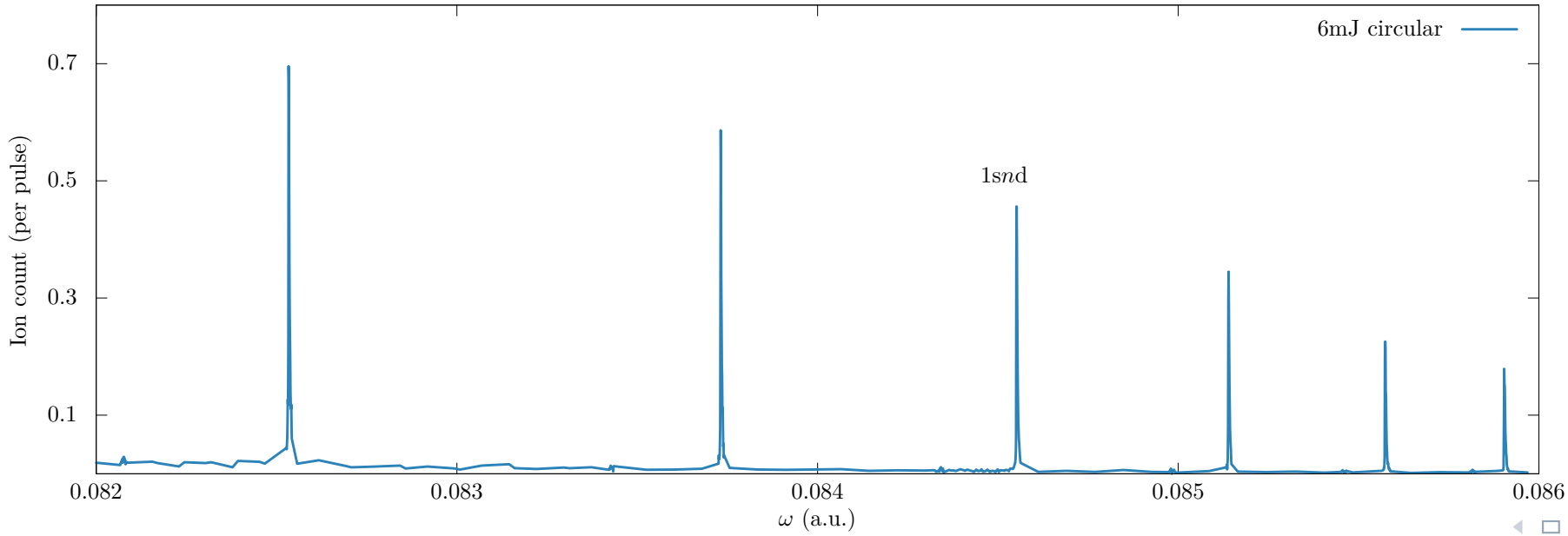

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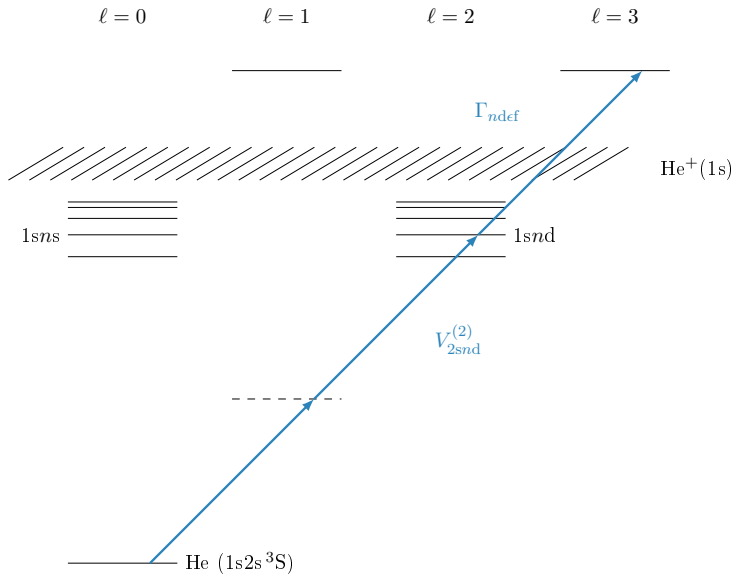

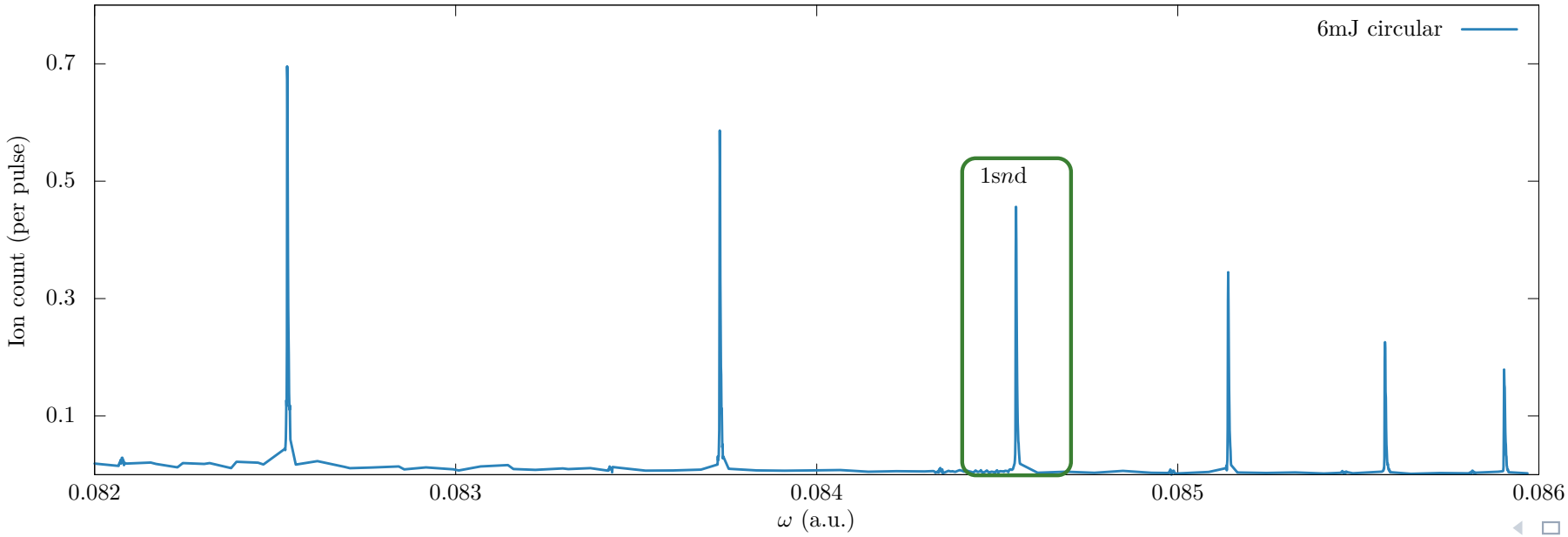

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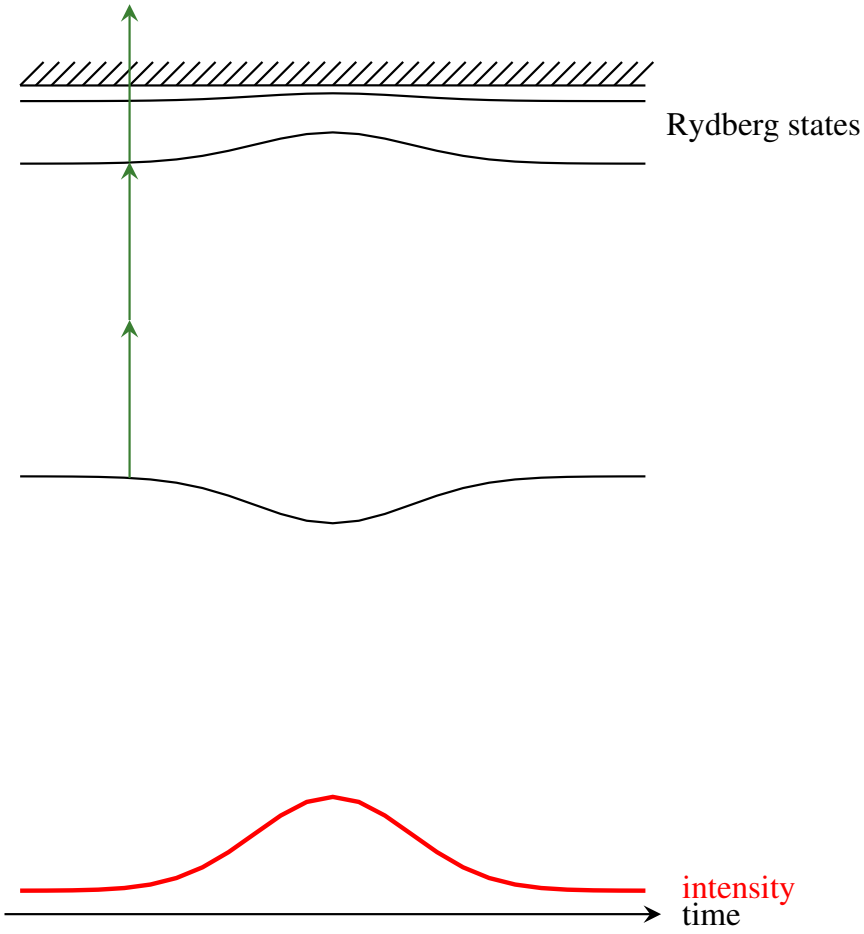
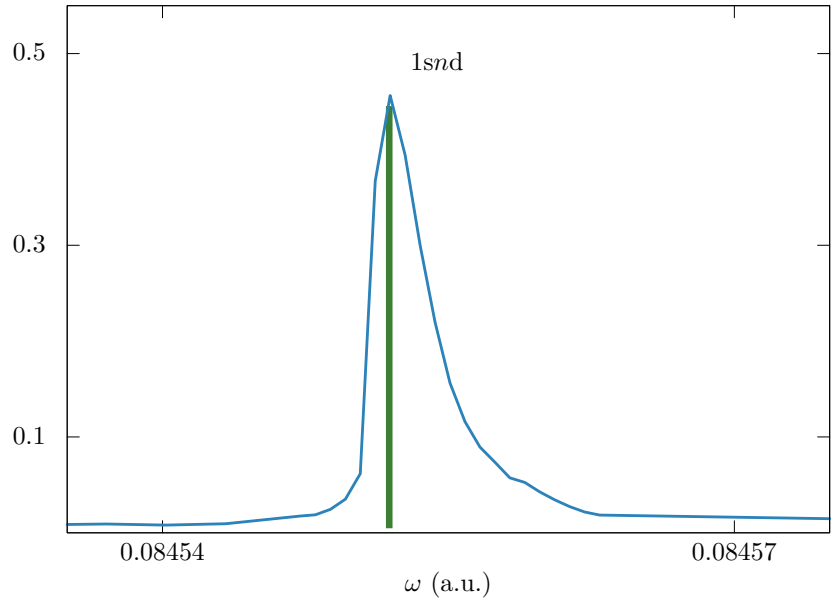


The intensity at which resonance occurs influences :

- Interaction time
- Number of atoms



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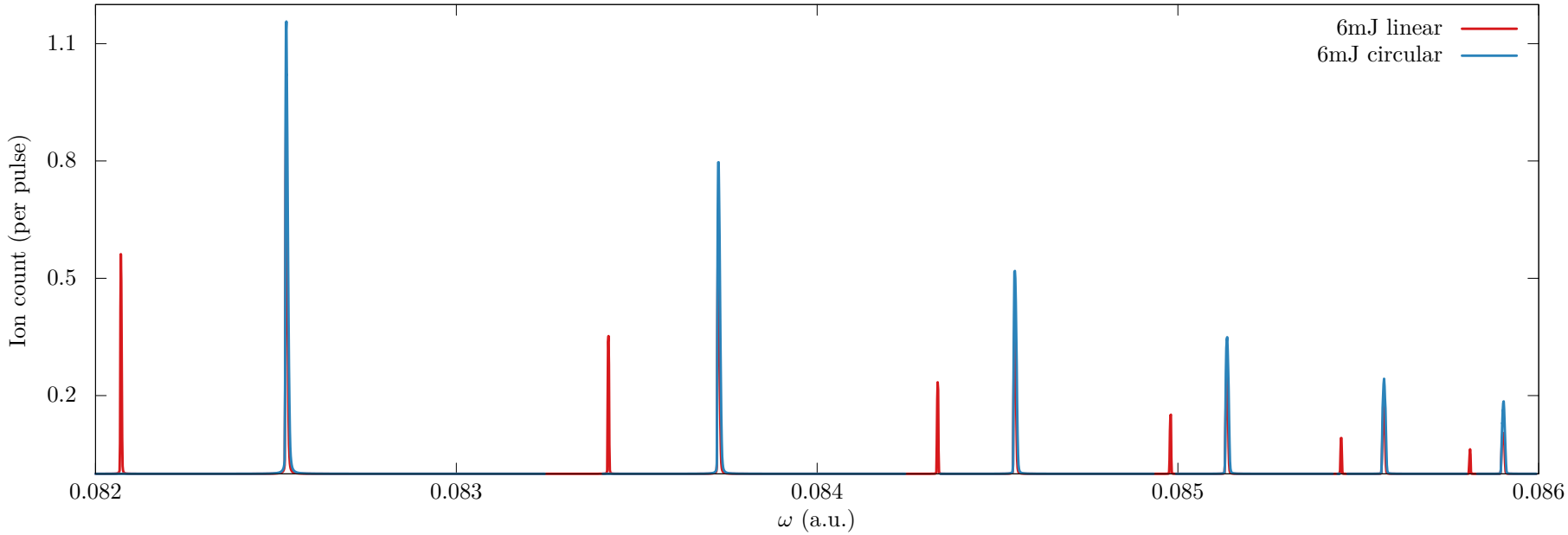
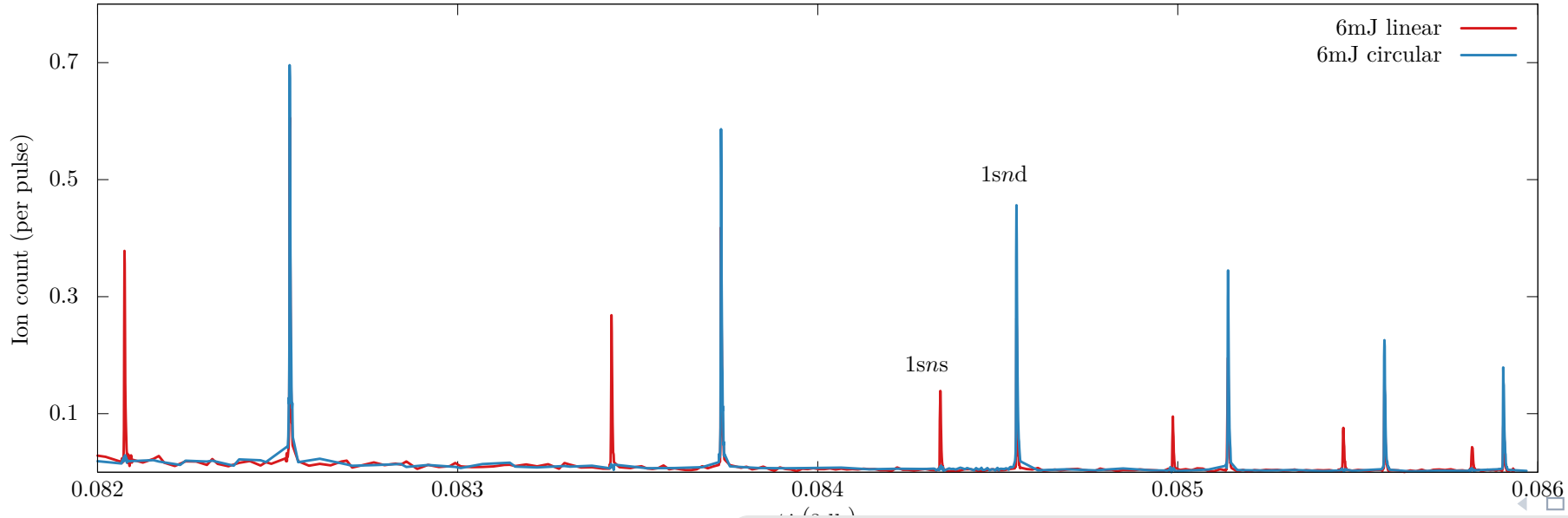
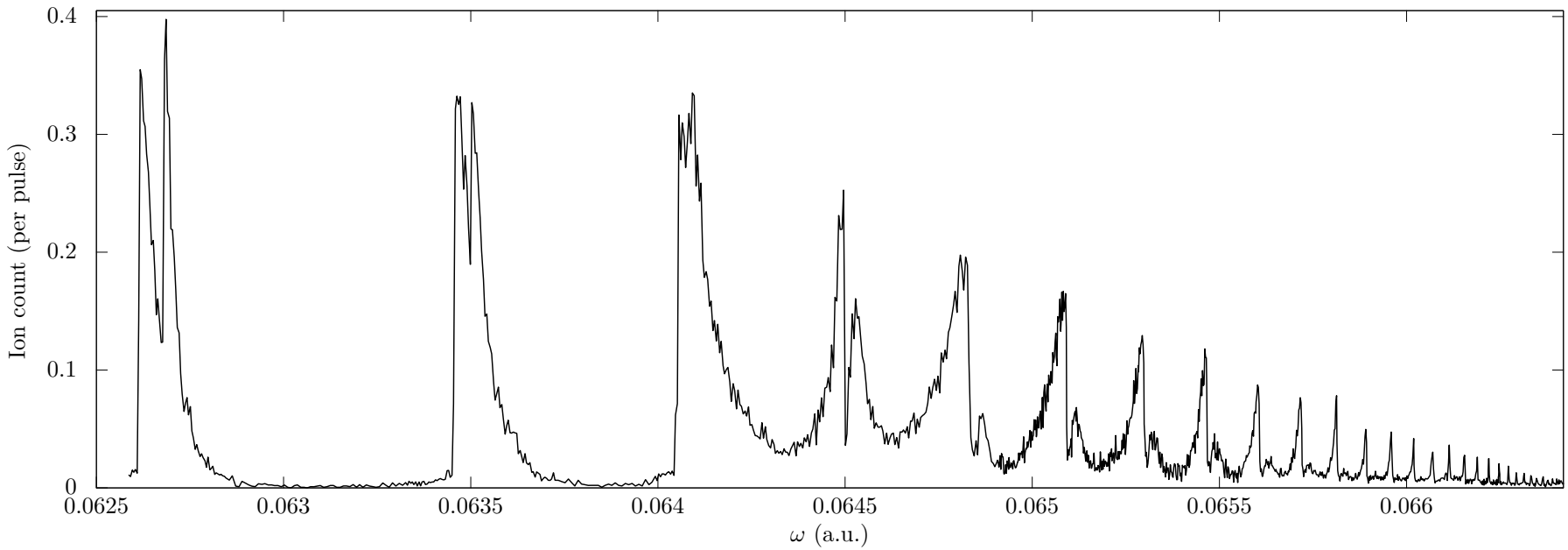




Increased complexity : the 1s2p $^3P^o$ state



He^- production

Double charge exchange between He^+ and cesium vapour $\rightarrow$ $He^-(1s2s2p\ ^4P^o)$

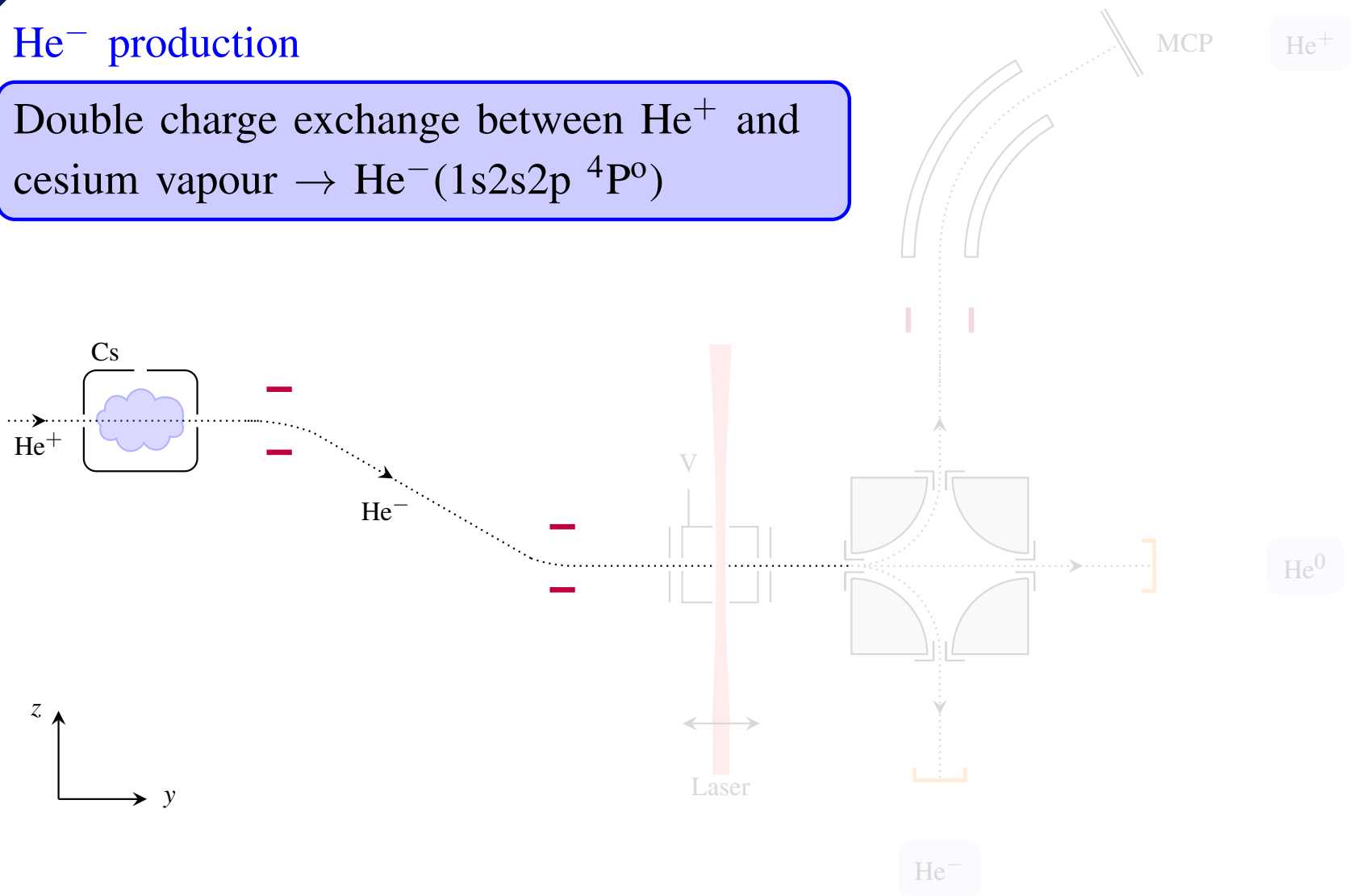
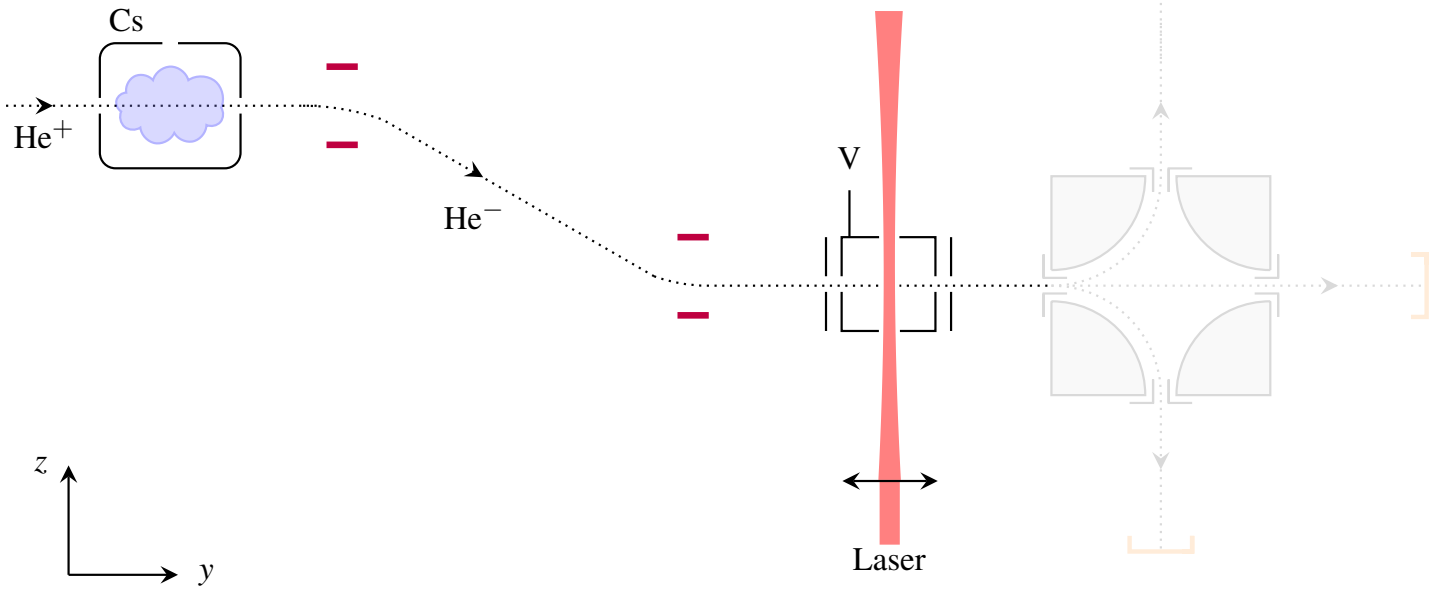


Photo-detachment and ionization

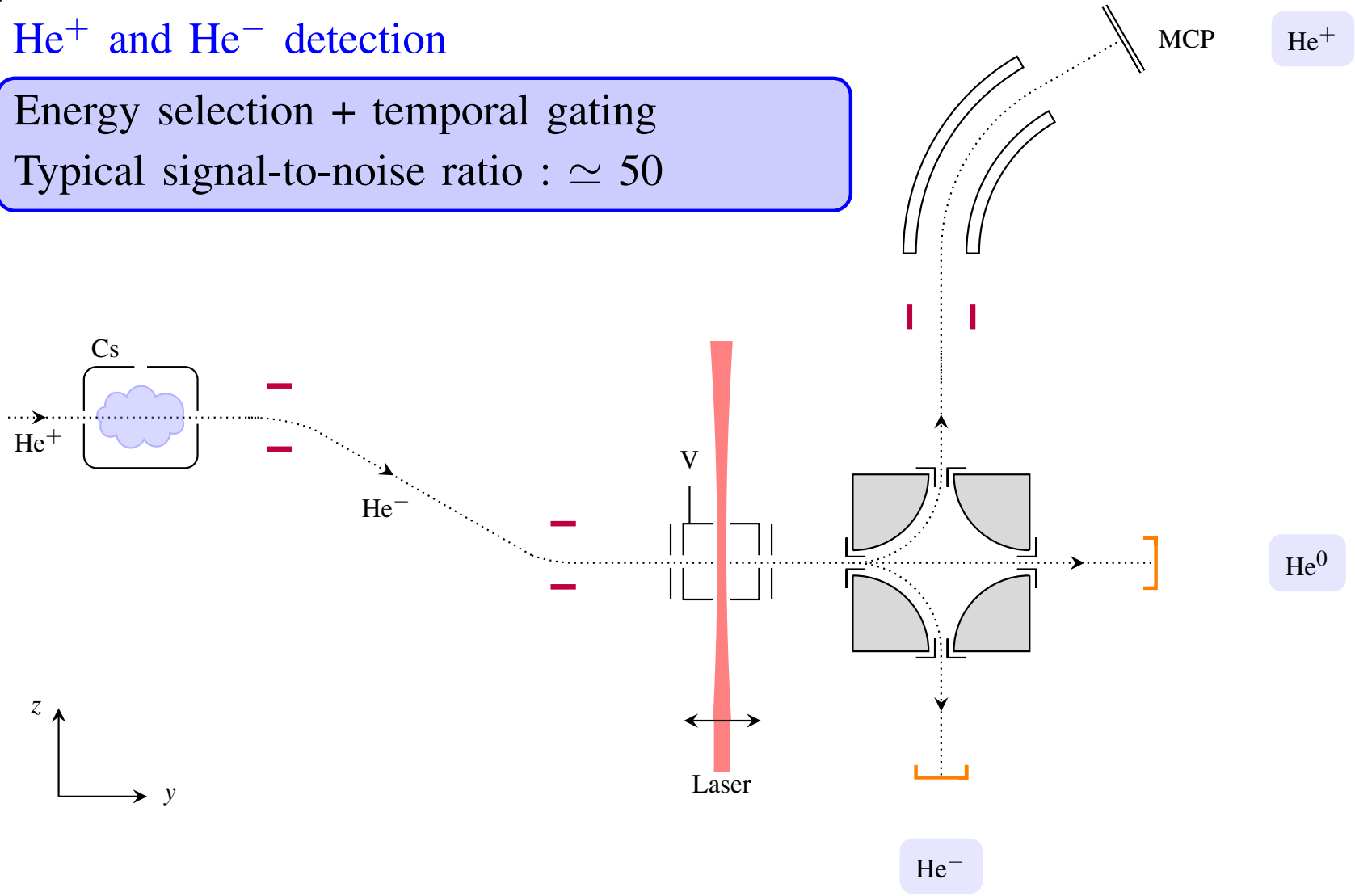
Pulsed dye laser pumped by the 2nd/3rd harmonics of Nd :YAG laser

$$He^- + \gamma \rightarrow He^0 + e^-$$
$$He^0 + 3\gamma \rightarrow He^+ + e^-$$

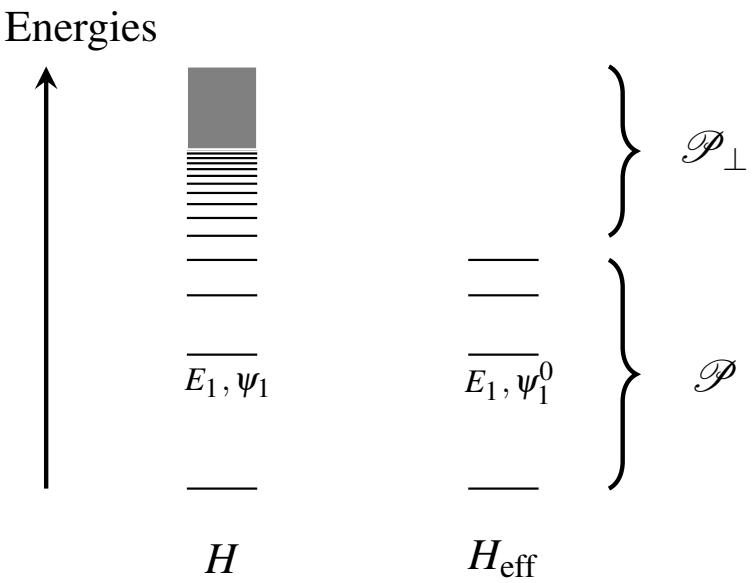


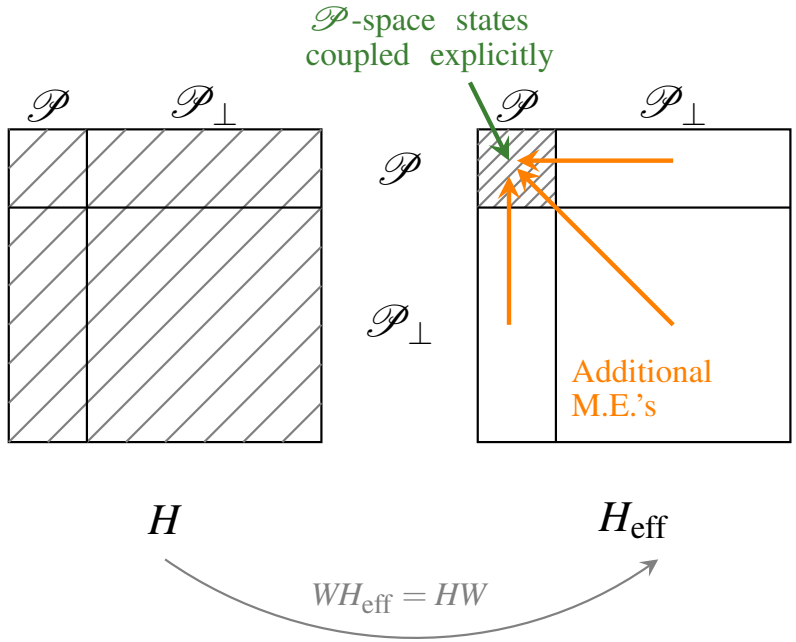
He^+ and He^- detection

Energy selection + temporal gating
Typical signal-to-noise ratio : $\simeq 50$



Effective Hamiltonian method





Matrix elements :

1. 2-electron Coulomb DVR basis + Quantum Defect Theory
2. Comparison with *ab initio* R-Matrix Floquet calculations

Durand, PRA 28 (1983) – Baker, PRA 30 (1984)

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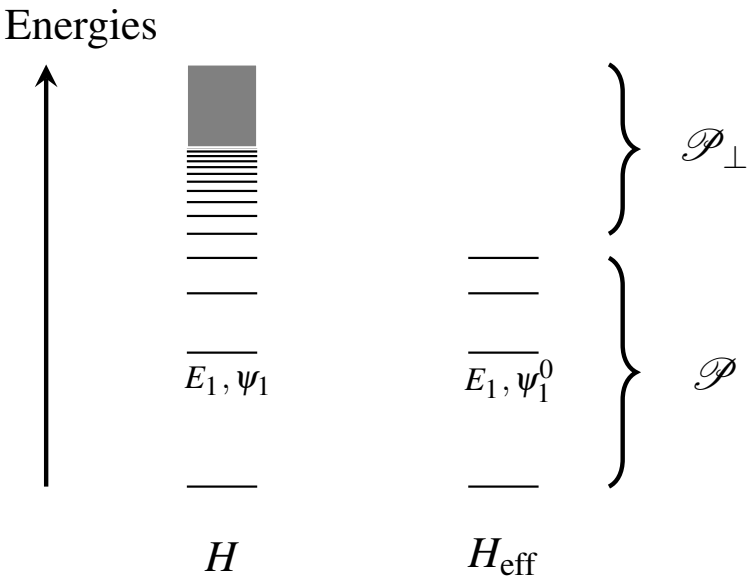

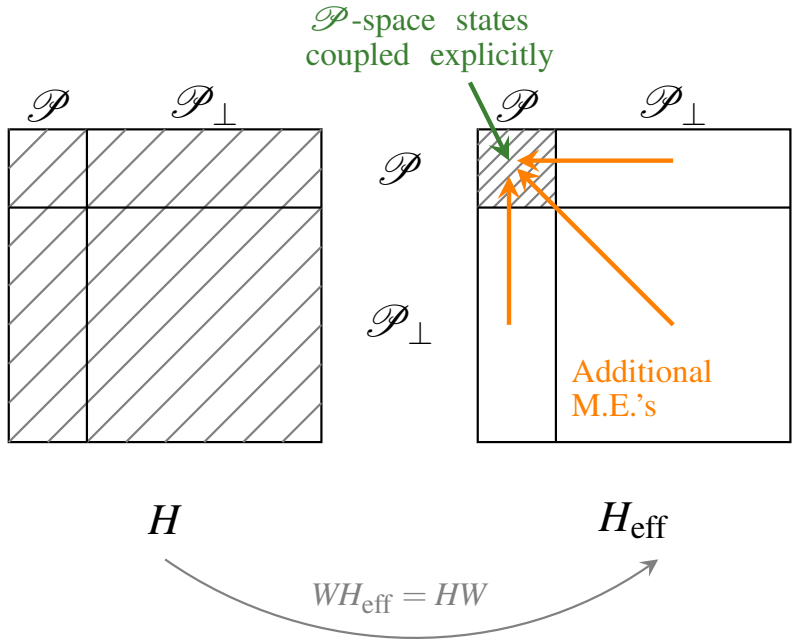

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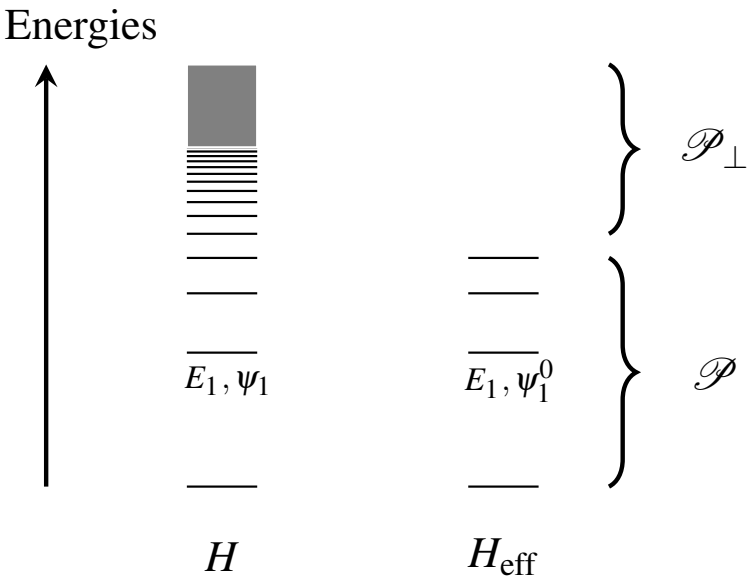
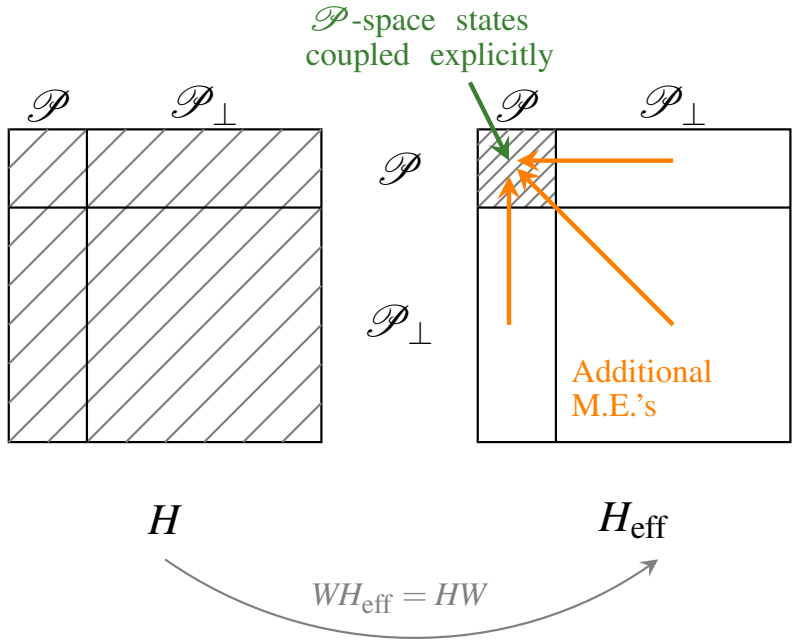




Model :

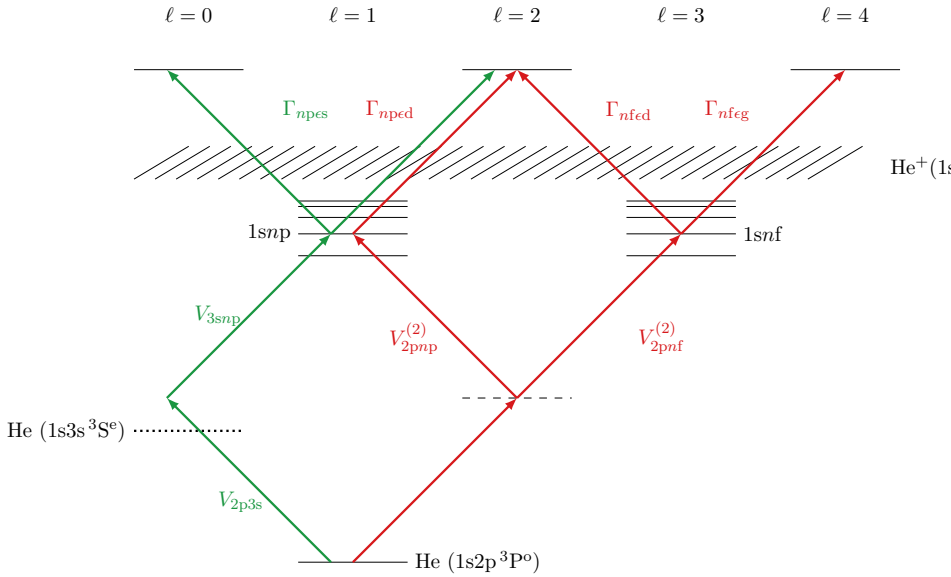
1. Time-propagation of H_{eff} for many intensities
2. Reconstruction of the experimental averaging and integration

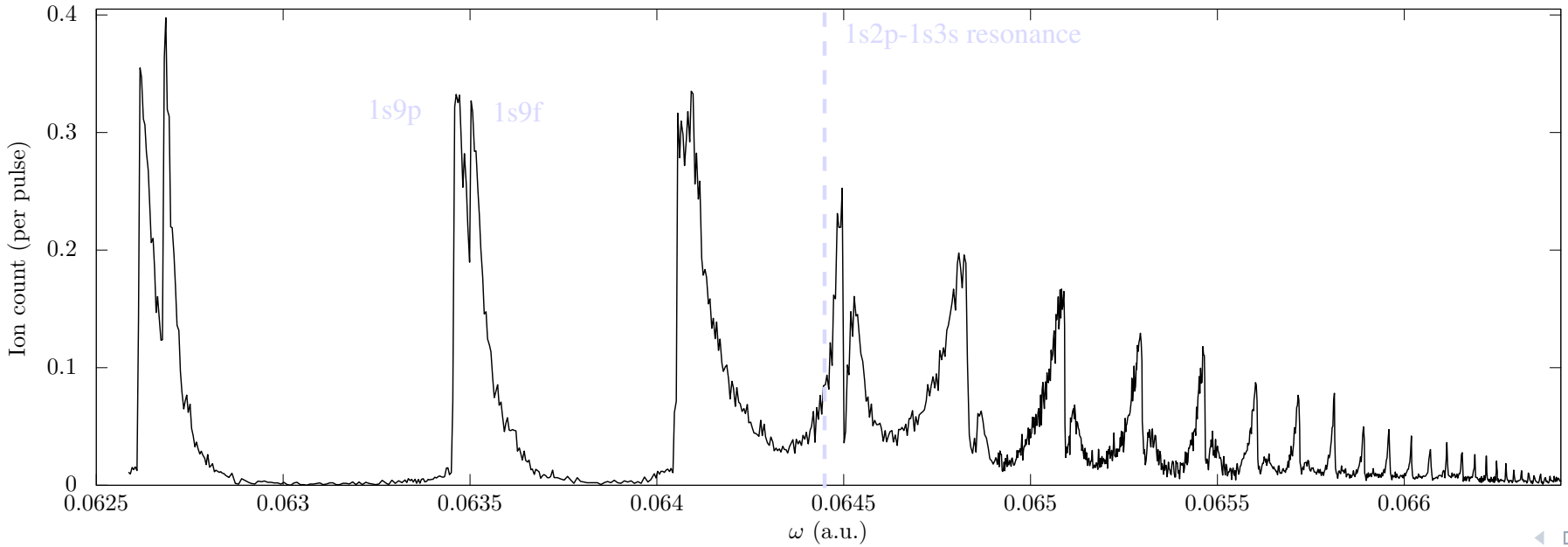
Durand, PRA 28 (1983) – Baker, PRA 30 (1984)

$1s2p\ ^3P^o$: linear polarization

Characteristics :

- (2+1) REMPI – $M_L = \pm 1$ (0)
- (1+1+1) REMPI – $M_L = 0$
- 680-730 nm
- $I \simeq 3 \times 10^{10}$ W/cm^2





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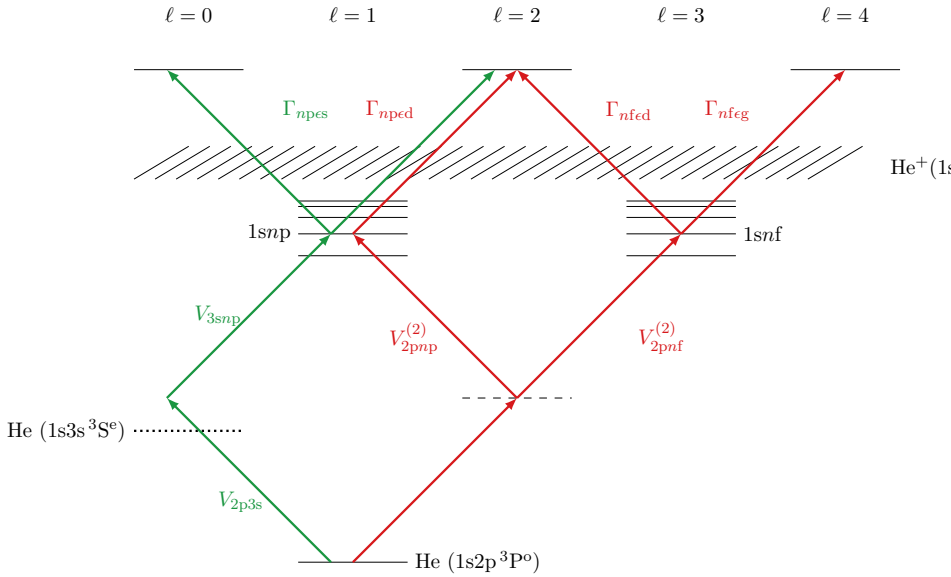
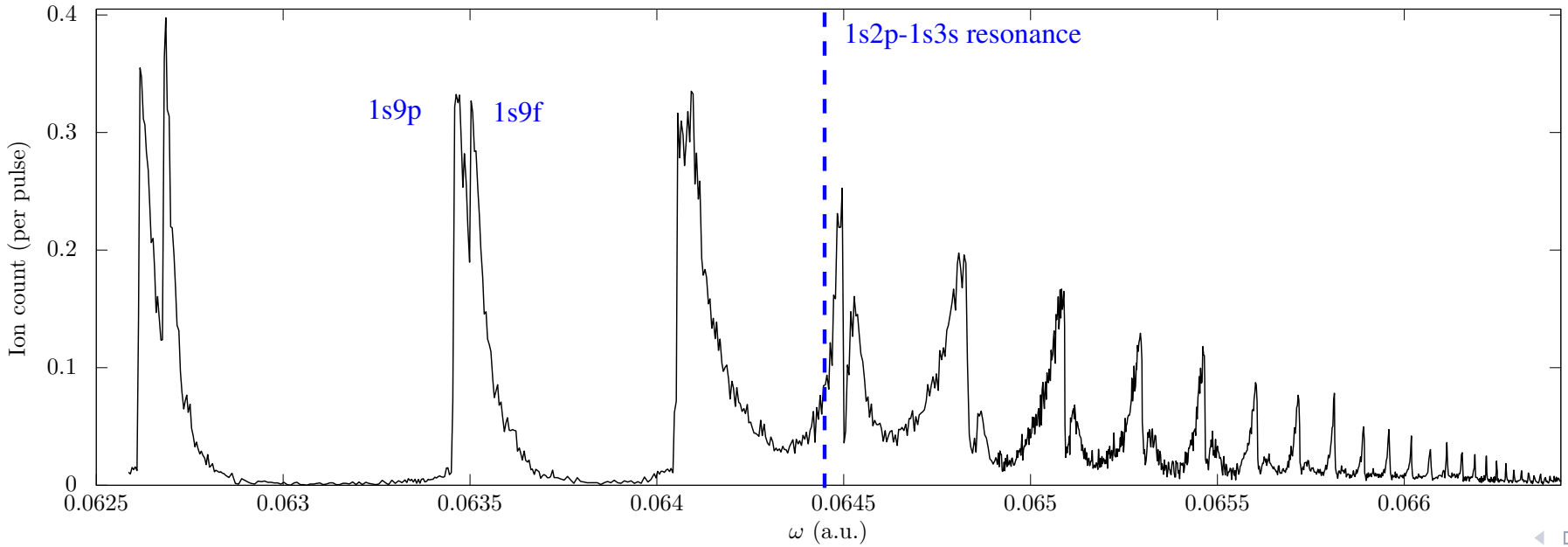
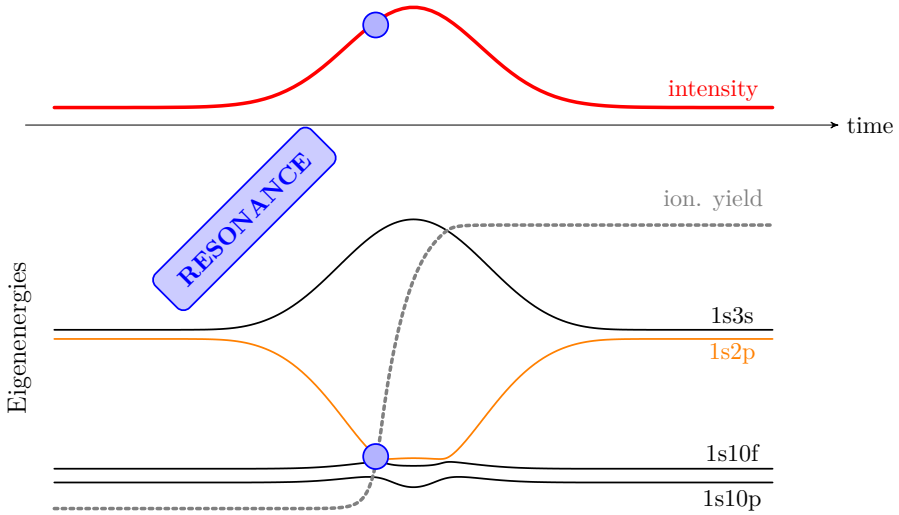
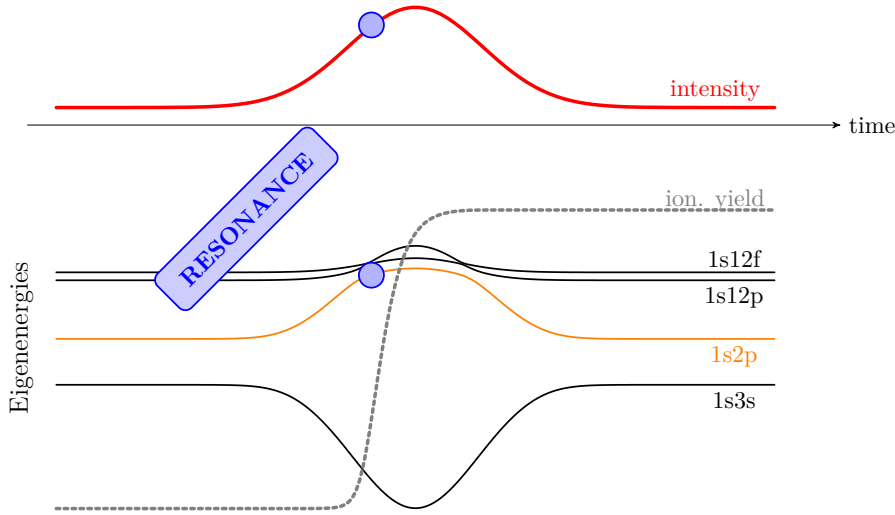
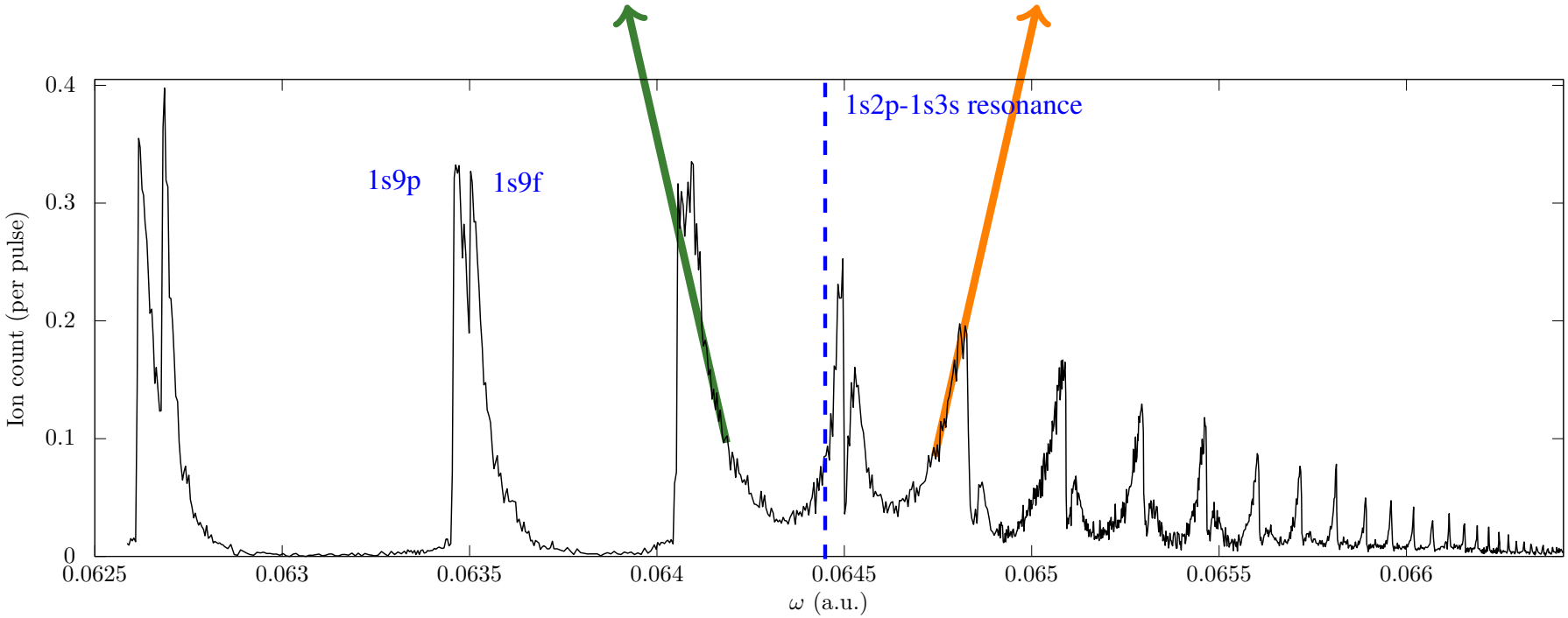




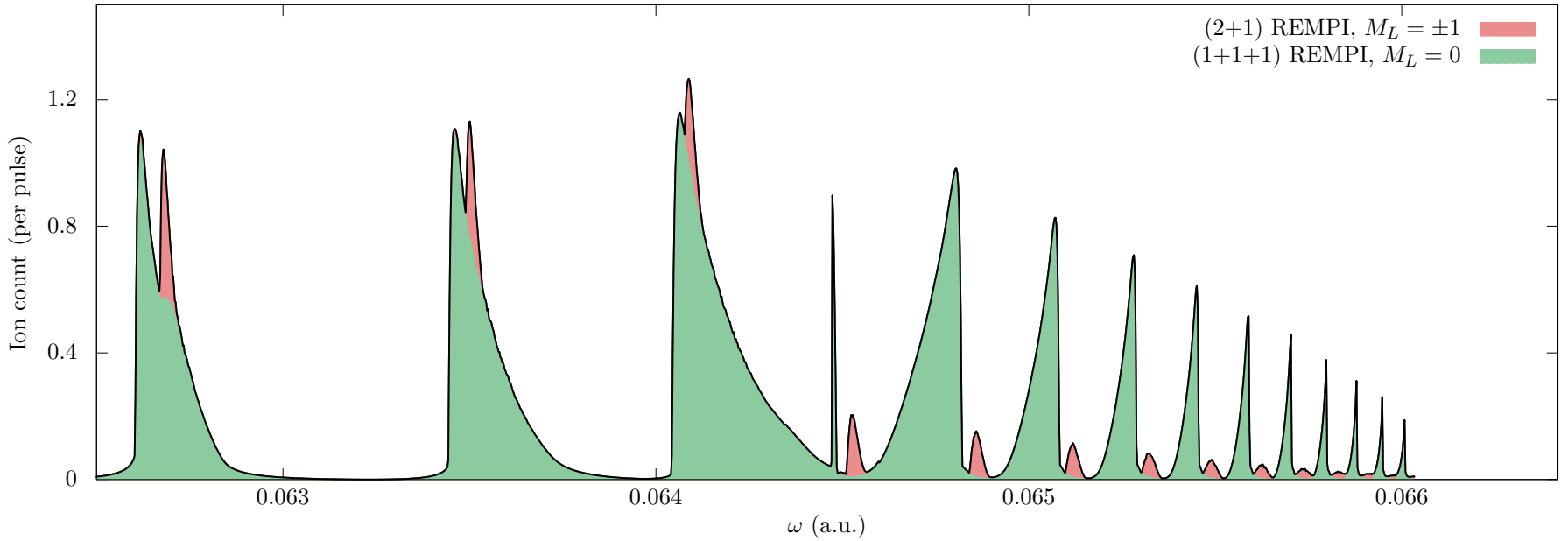
1s2p $^3P^o$: across the 1s2p-1s3s resonance

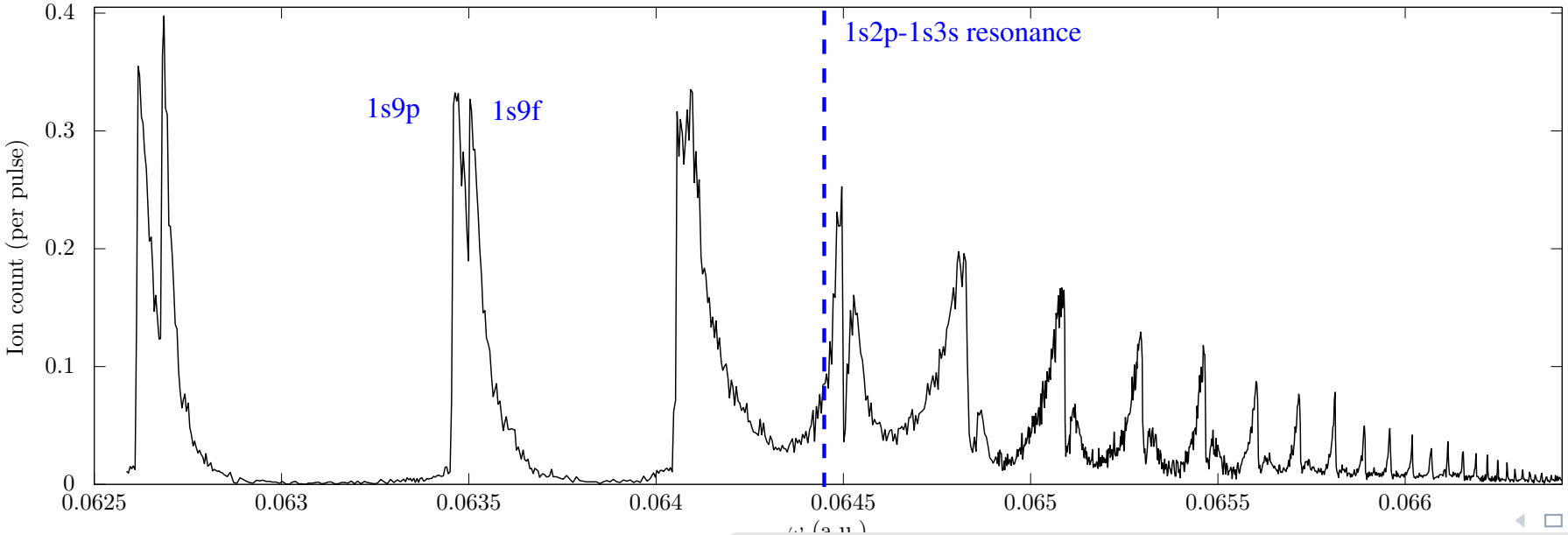




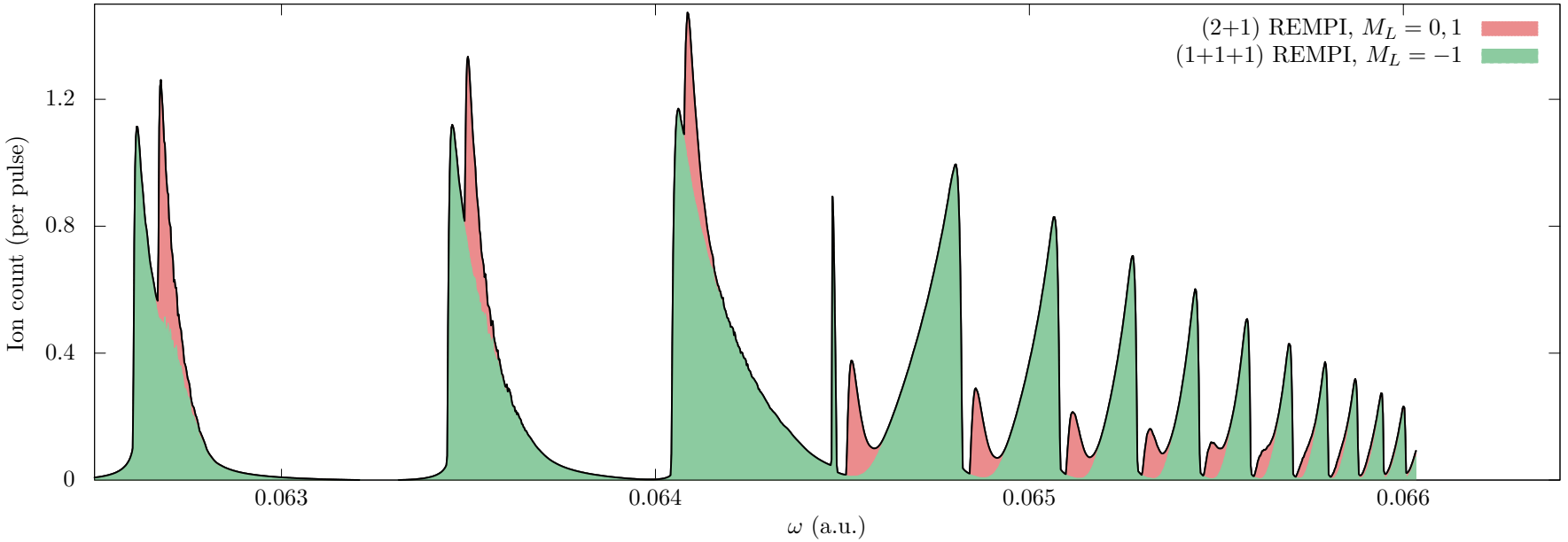


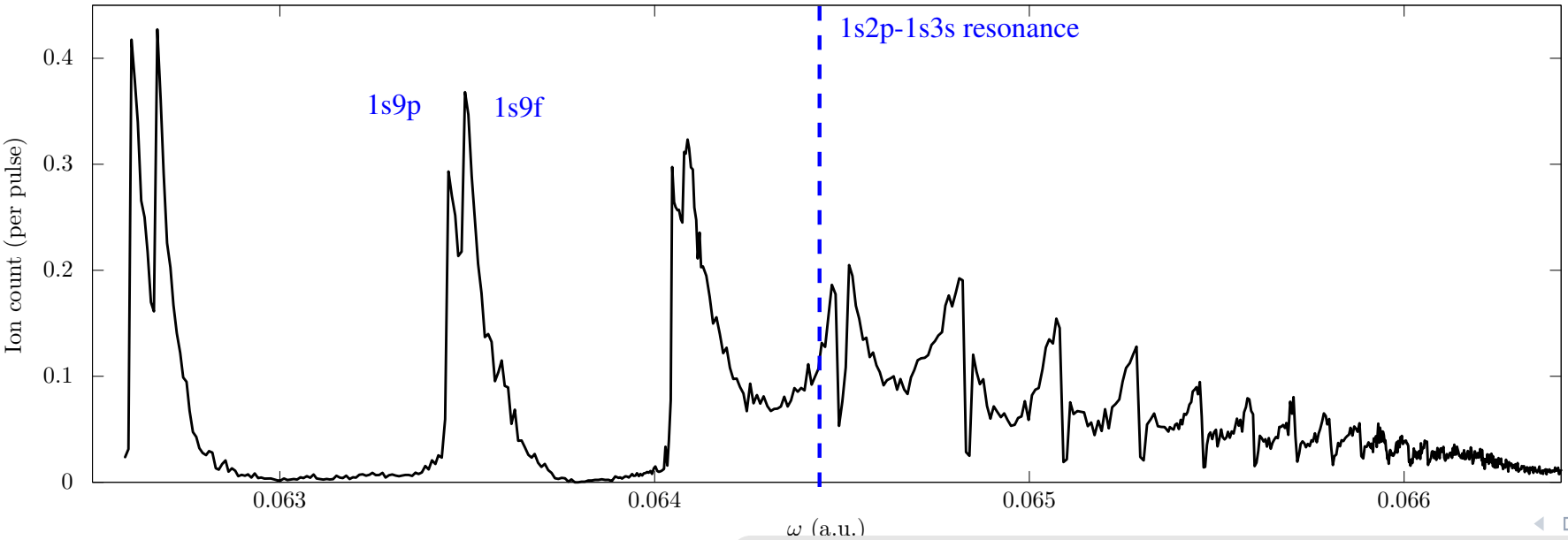
1s2p $^3P^o$: linear polarization





1s2p $^3P^o$: circular polarization





Conclusion

- In-depth study of multiphoton ionization from excited states of Helium
- Particular features due to intermediate resonances
- From (2+1) REMPI to (1+1+1) REMPI
- Influence of M_L, polarization

Acknowledgements

X. Urbain, A. O'Connor, M. Terao-Dunseath, K.M. Dunseath

More information :

M. Génévriez, X. Urbain, M. Brouri, A.P. O'Connor, K.M. Dunseath, M. Terao-Dunseath, Phys. Rev. A **89**, 053430 (2014)

Acknowledgements

Thank you for your attention !

More information :

M. Génévriez, X. Urbain, M. Brouri, A.P. O'Connor, K.M. Dunseath, M. Terao-Dunseath, Phys. Rev. A **89**, 053430 (2014)