Strong Field Physics

Connection between Quantum and Classical in Real Space

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- Wavefunction in Real Space
- Partial Differential Equation
- Widely accepted by physicists at that age:
  spectrum, scattering, etc.

$$i\partial_t\psi(\boldsymbol{r},t)=\left(-\frac{\nabla^2}{2}+V\right)\psi(\boldsymbol{r},t)$$

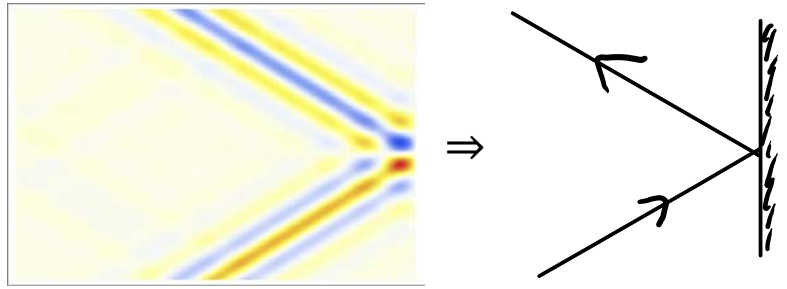
- Matrix in Hilbert Space
- Linear Algebra
- Preferred by nowadays physicists:
  quantum information, cold atom, condense matter, etc.

$$[x_i,p_j]=i\delta_{ij}$$

Quantum-Classical Correspondence:

- Qubit ⇒ bit
- Wavepacket ⇒ mass point?

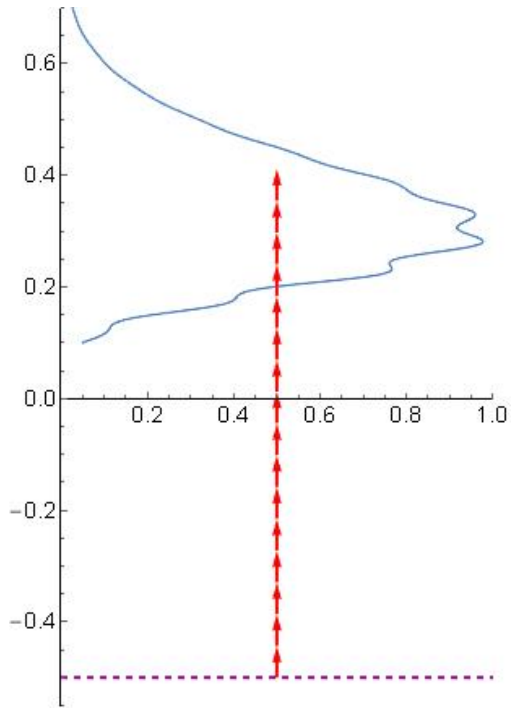
$$\begin{pmatrix}1/2 & 1/2\\ 1/2 & 1/2\end{pmatrix}\Rightarrow\begin{pmatrix}1/2 & 0\\ 0 & 1/2\end{pmatrix}$$

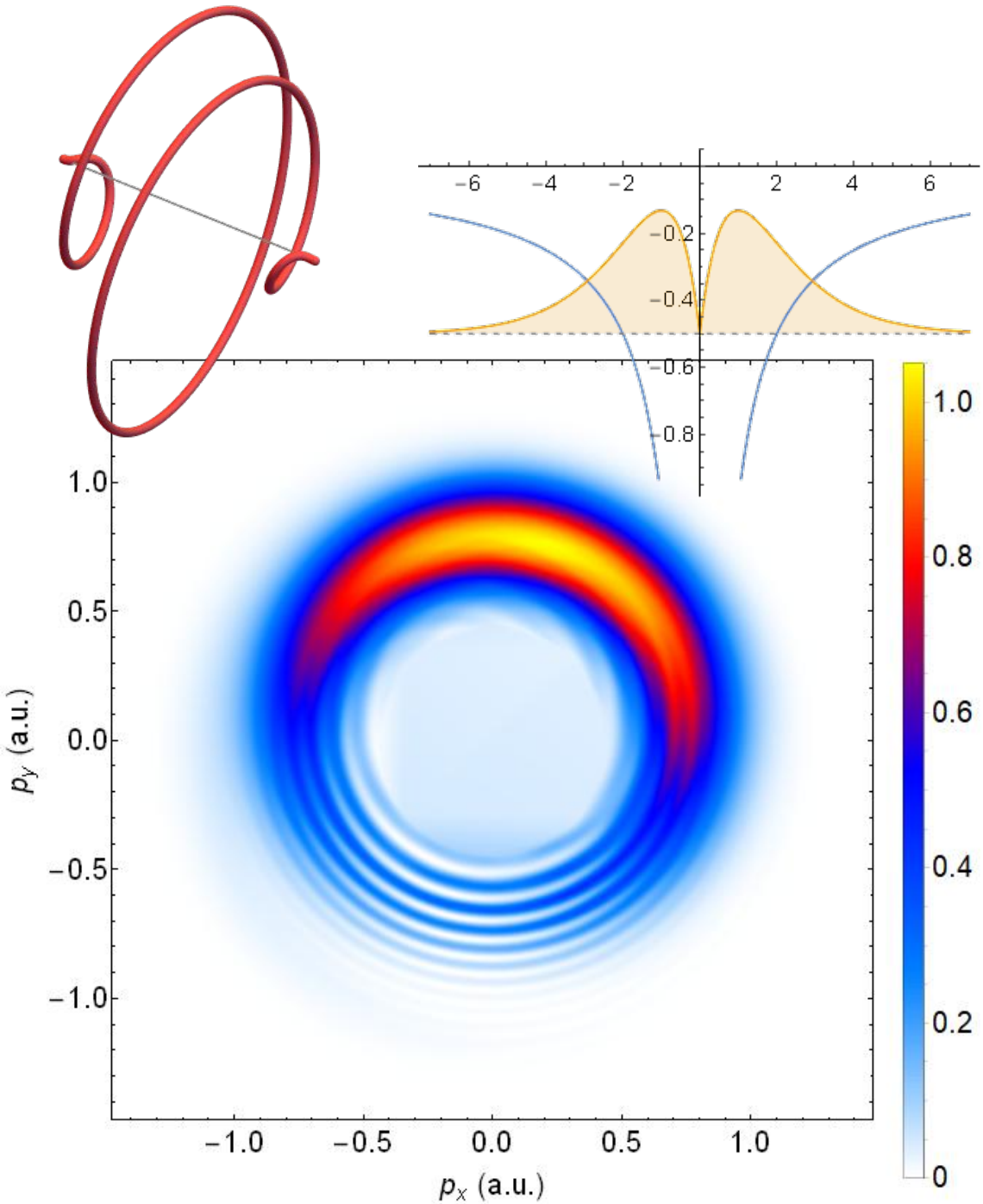


Strong Field Physics

Atom ionized by a short circular IR pulse

Electron absorbing photons:
- Huge number of
- Even after its energy larger than ionization threshold.
- More is larger than less.

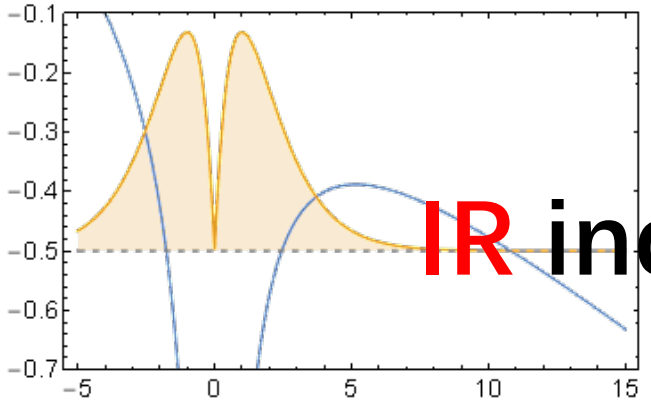




Atom ionized by a short circular IR pulse

Picture in time & space domain:

- Electron tunnel through field-induced barrier

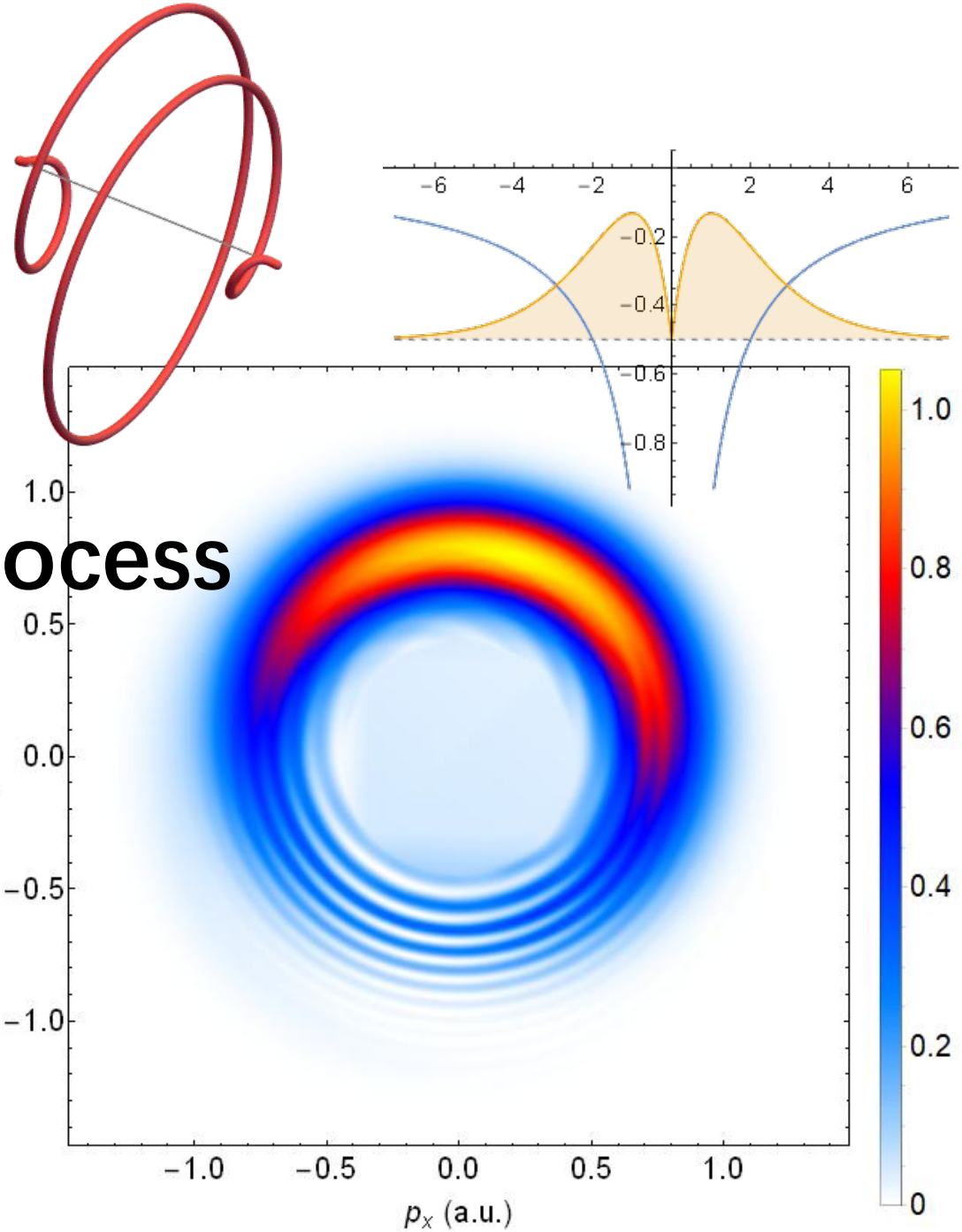


- Moving in laser field with Newton equation

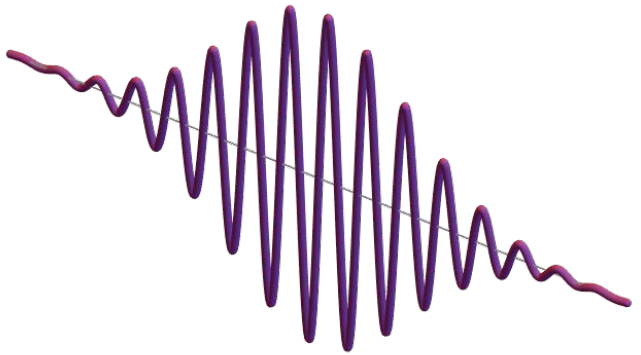
$$\Delta \boldsymbol{p} = -\int \boldsymbol{E} dt = \boldsymbol{A}(t_\infty) - \boldsymbol{A}(t_i)$$

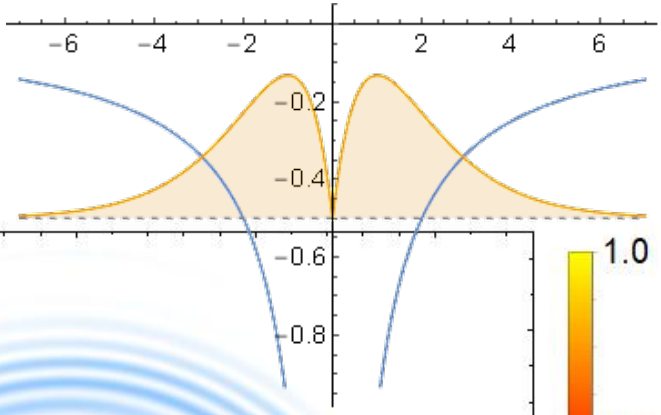
- Interference between different cycles

IR induced UV process



Atom ionized by a long linear UV pulse





UV induced IR process

Picture in frequency domain:

- Ramen effect.

Picture in time & space domain:

- Radiative Pressure

$$f = -\frac{\partial}{\partial z}U_p = \frac{1}{2c}\frac{\partial}{\partial t}\overline{A^2(t)}$$

- Finite displacement driven by envelope

$$\Delta z = \iint f = \frac{1}{2c}\int A^2(t)dt$$

- Diffracted by ion and low energy structure appears