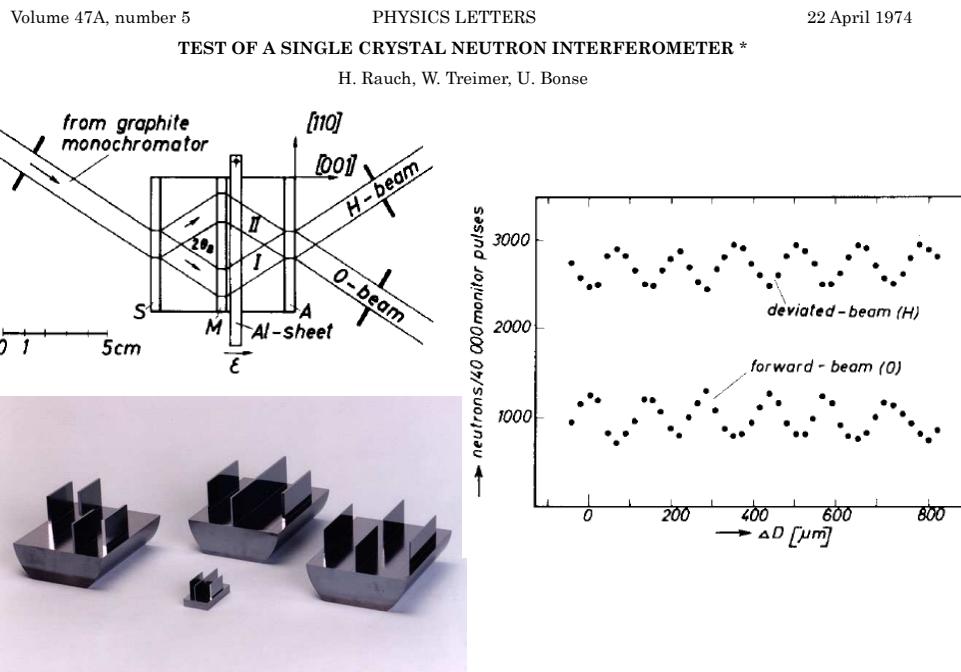


Plan du cours

1. Introduction; cohérence quantique & limitations
2. Champ quantique : un système modèle et un modèle d'environnement
3. L'opérateur densité
4. Mouvement brownien classique; Approches quantique de la relaxation
5. L'équation pilote et le mouvement brownien quantique
6. Décohérence, « chat de Schrödinger », Applications à la théorie de la mesure
7. L'approche « fonctions d'onde stochastiques ».

Cours 1

- Contexte et objectifs
- 1. Interféromètre de matière:
Principe, application aux neutrons, atomes et molécules
- 2. Fonctions d'onde macroscopiques
Notions sur la CBE, Réalisation exp., Expérience de chute libre à 2 sources
- 3. Le brouillage de la cohérence dans une expérience d'Young
Which-path; gomme quantique; température



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- S. Haroche, cours du CdF <http://www.cqed.org/college/collegeparis.html>
- C. Fabre, cours de CFP <http://www.phys.ens.fr/cours/notes-de-cours/Fabre/polyM2PhQuant2006.pdf>

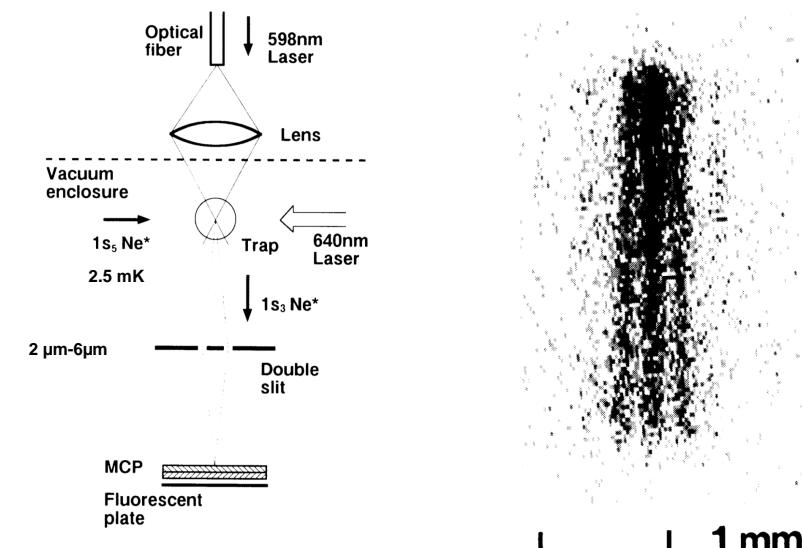
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- L. Davidovich, Sub-Poissonian processes in quantum optics, Rev. Mod. Phys. **68**, 127–173 (1996), <http://link.aps.org/doi/10.1103/RevModPhys.68.127>
- W. H. Zurek , Decoherence, einselection, and the quantum origins of the classical, Rev. Mod. Phys. **75**, 715–775 (2003), <http://link.aps.org/doi/10.1103/RevModPhys.75.715>
- M. B. Plenio and P. L. Knight, The quantum-jump approach to dissipative dynamics in quantum optics, Rev. Mod. Phys. **70**, 101–144 (1998) <http://link.aps.org/doi/10.1103/RevModPhys.70.101>

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- C. Cohen-Tannoudji et al : *Processus d'interaction entre photons et atomes* Interéditions/Editions du CNRS (le « cohen rouge »)
- S. Haroche and J.M. Raimond : *Exploring the Quantum, Atoms, Cavities and Photons, Oxford graduate texts*

PHYSICAL REVIEW A VOLUME 46, NUMBER 1 1st JULY 92
Double slit interference with ultracold metastable neon atoms
Fujiio Shimizu, Kazuko Shimizu, Hiroshi Takuma



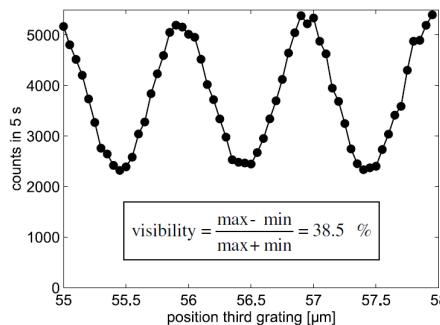
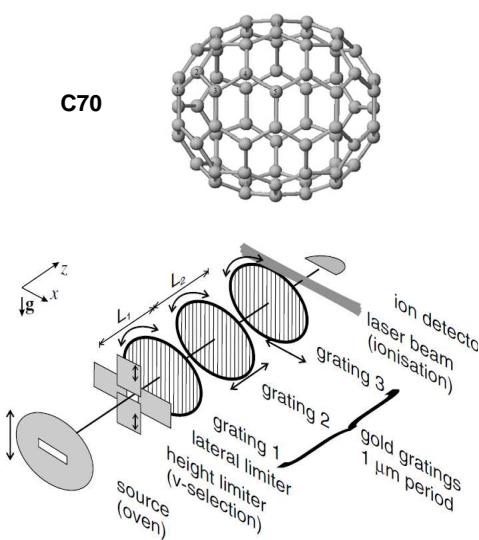
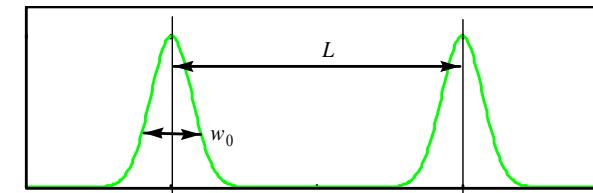


FIG. 2. Interference fringes (raw data) resulting from a typical single scan of the third grating. A central velocity of 115 m/s was selected.

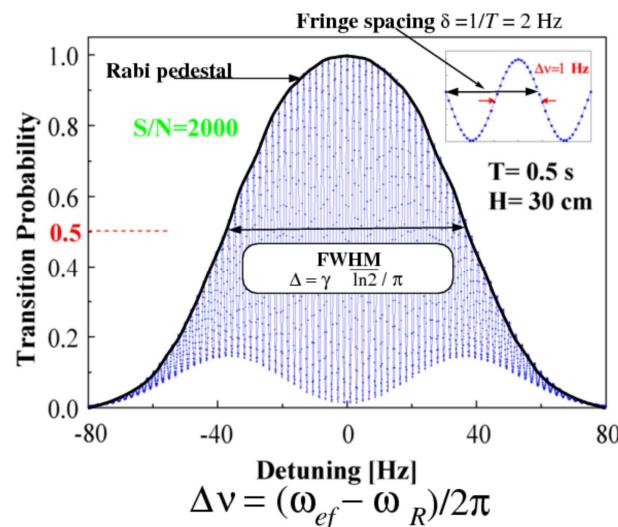
Ramsey method

- Time dependant perturbations $a_{i \rightarrow f}(t) \propto \int_0^t V_{fi}(t') \exp(i\omega_{fi}t') dt'$
- Atom-field coupling $V(t) = -\hat{\mathbf{d}} \cdot \mathbf{E}(\mathbf{R}, t)$
- Single interaction $\mathbf{E}(\mathbf{R}, t) = \mathbf{E}_0 \cos(\omega_L t) \exp(-Z^2/w_0^2)$
- Rabi signal $P_{i \rightarrow f}(t) \propto \Omega_R^2 \exp[-(\omega_L - \omega_{if})^2 \left(\frac{w_0}{v} \right)^2]$
- Méthode des champ séparés :
2 interactions
 $\mathbf{E}(t) = \mathbf{E}_0 \cos(\omega_L t) [\exp(-(vt)^2/w_0^2) + \exp(-(vt-L)^2/w_0^2)]$



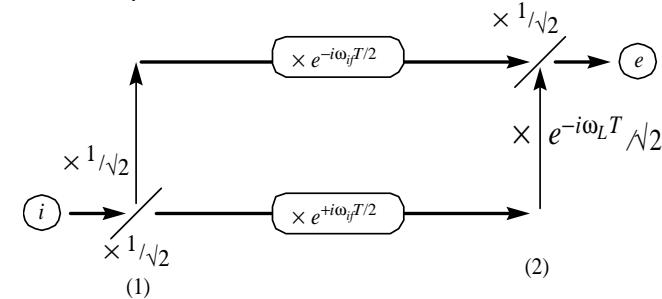
Ramsey fringes (atomic fountain PHARAO)

$$P'_{i \rightarrow f}(t) \propto P_{i \rightarrow f}(t) \times \cos^2 \left(\frac{1}{2} (\omega_L - \omega_{if}) \frac{L}{v} \right)$$



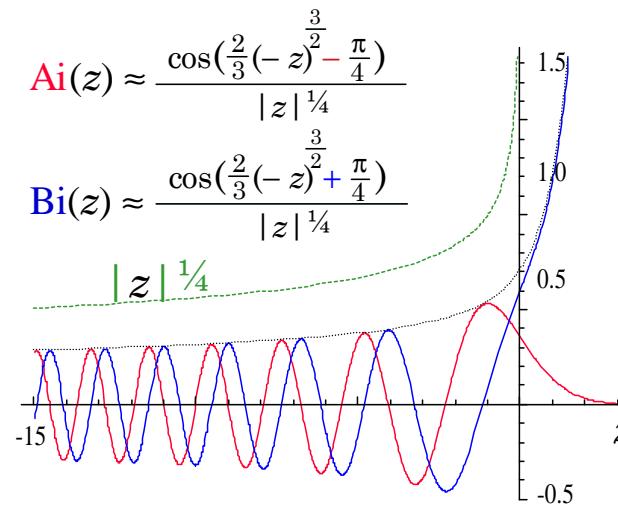
Ramsey : interferometric point of view

- $\pi/2$ Impulsion = beam splitter
 $\mathbf{S}(\theta) = \begin{bmatrix} \cos(\theta/2) & \sin(\theta/2) \\ -\sin(\theta/2) & \cos(\theta/2) \end{bmatrix} \xrightarrow{\theta=\pi/2} \mathbf{S} = \begin{bmatrix} \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \\ -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{2}} \end{bmatrix}$
- Free evolution
 $\mathbf{U} = \begin{bmatrix} e^{-i\omega_f T/2} & 0 \\ 0 & e^{+i\omega_f T/2} \end{bmatrix}$
- Second $\pi/2$ impulsion = recombination

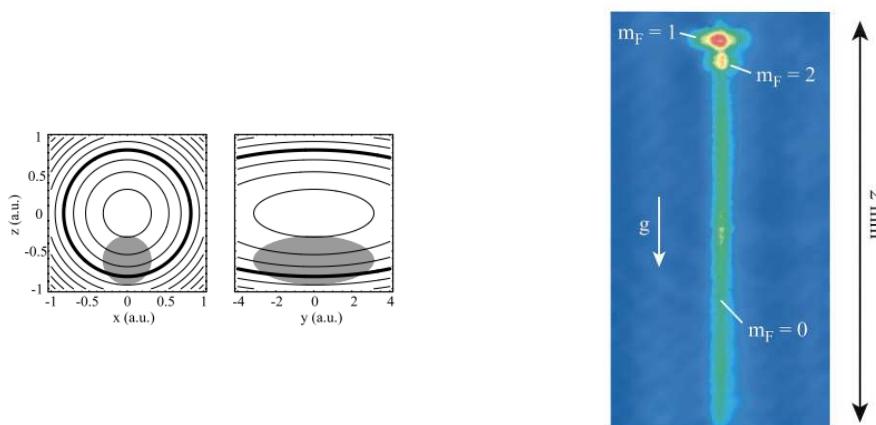


La fonction d'onde : fonctions d'Airy

$$\psi'' - z \psi(z) = 0$$

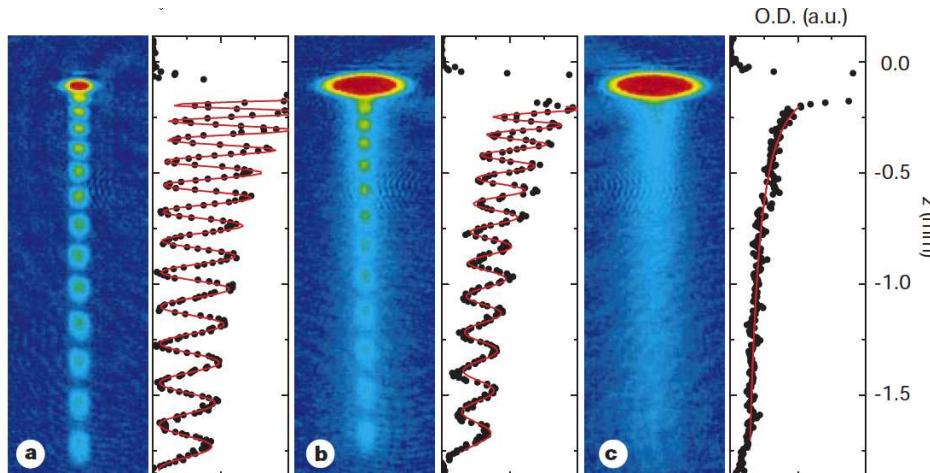


Extraction par radiofréquence



Immanuel Bloch, Theodor W. Hänsch, and Tilman Esslinger
Atom Laser with a cw Output Coupler, PRL 82 (1999)

NATURE
VOL 403
13 JANUARY 2000
**Measurement of the spatial coherence of a trapped Bose gas
at the phase transition**
I. Bloch, T. W. Hänsch & T. Esslinger



Welcher Weg ---- Which-path

