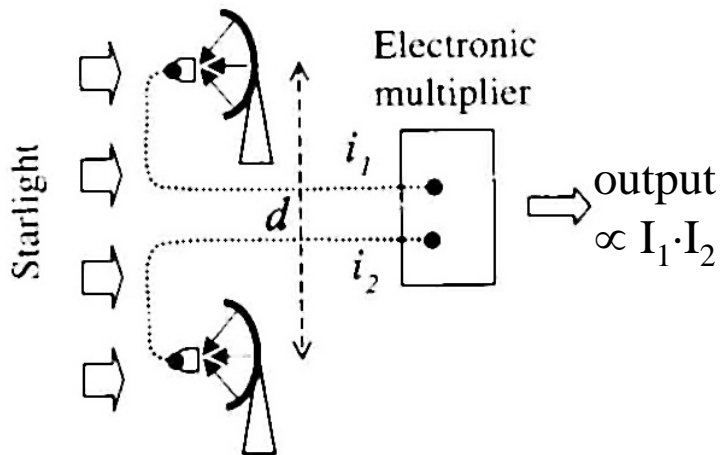


# $g^{(2)}(\tau)$ in Astronomy

Stellar size measurements:

- Measurement  $g^{(2)}(0)$  vs. detector separation
- Determines **spatial coherence**.
- Infer **source size**.

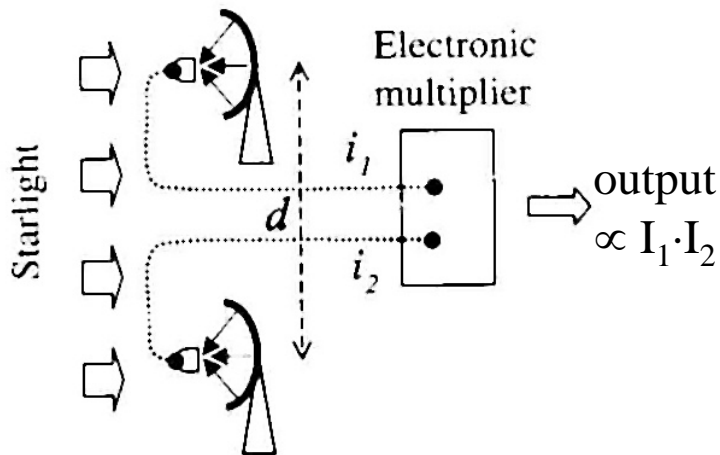


*Hanbury Brown – Twiss Experiment*

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Hanbury Brown – Twiss Experiment

[figure adapted from, *Quantum Optics* by M. Fox]

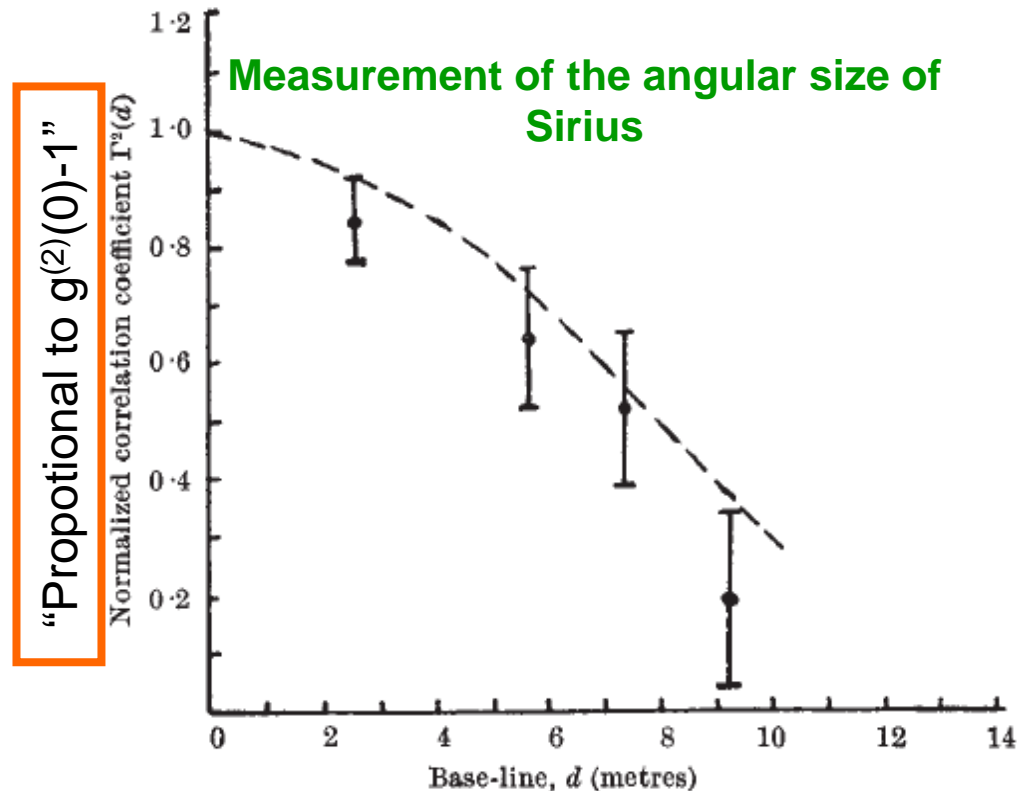


Fig. 2. Comparison between the values of the normalized correlation coefficient  $\Gamma^2(d)$  observed from Sirius and the theoretical values for a star of angular diameter  $0.0063''$ . The errors shown are the probable errors of the observations

[R. Hanbury Brown and R. Q. Twiss, *Nature* 178, 1046 (1956).]

# $g^{(2)}(\tau)$ in Biophysics

Fluorescence Correlation Spectroscopy (FCS) measures  $g^{(2)}(\tau)$  in biochemical systems.

FCS is used to determine:

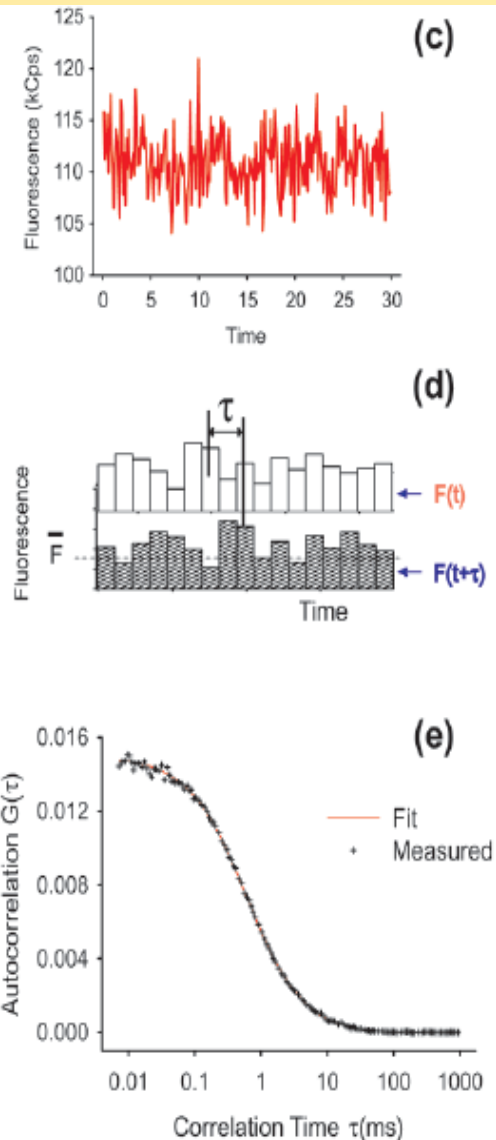
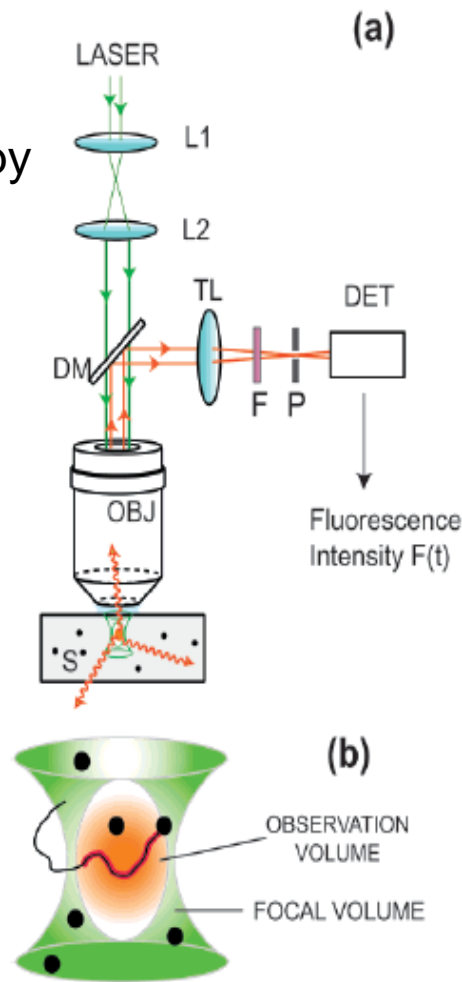
- **diffusion** constants.
- Chemical **reaction rates**.
- **Concentrations**.
- **Aggregation** of particles.
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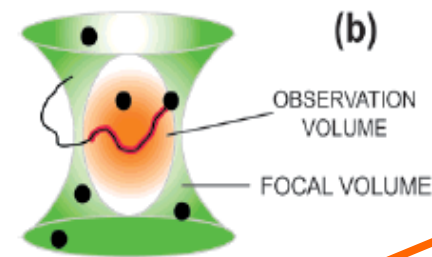
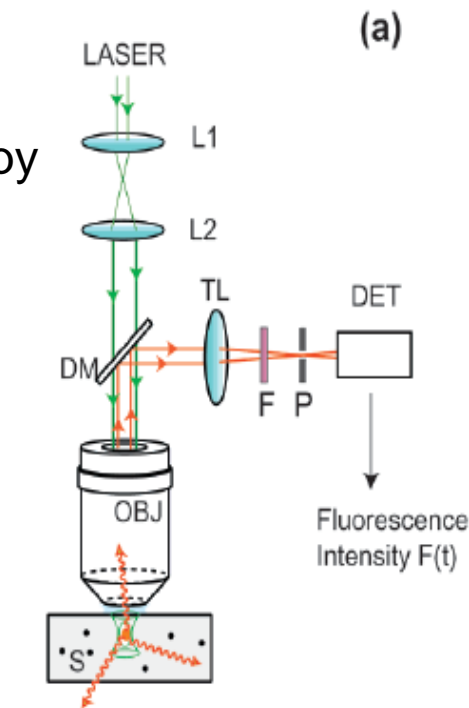


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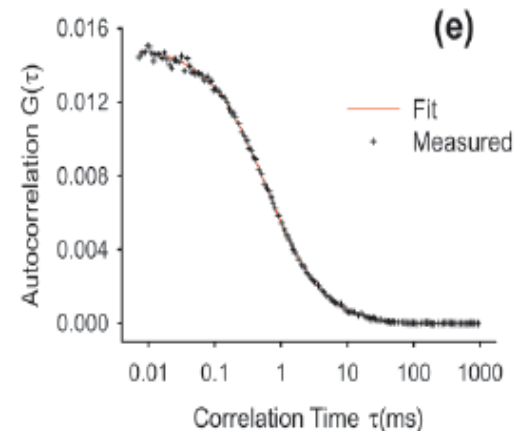
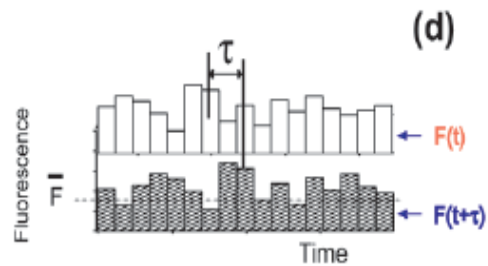
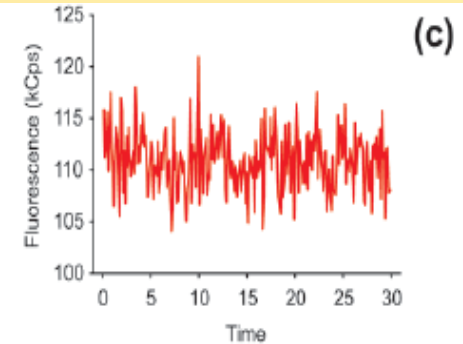
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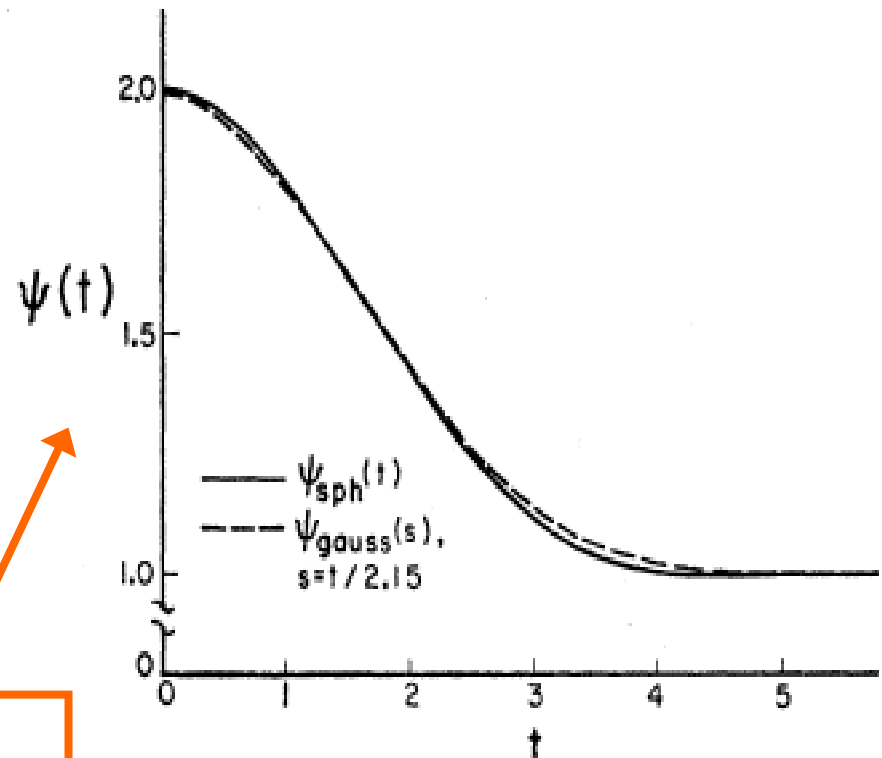
# $g^{(2)}(\tau)$ in Nuclear Physics

## Basic Idea:

➤ Use **Hanbury Brown – Twiss** to measure **spatial-temporal size** of interaction regions in nuclear collision reactions.

➤ **Correlation angles** of **Pions** emitted in a hadronization jet can be used to determine size of source.

$g^{(2)}(\tau)$



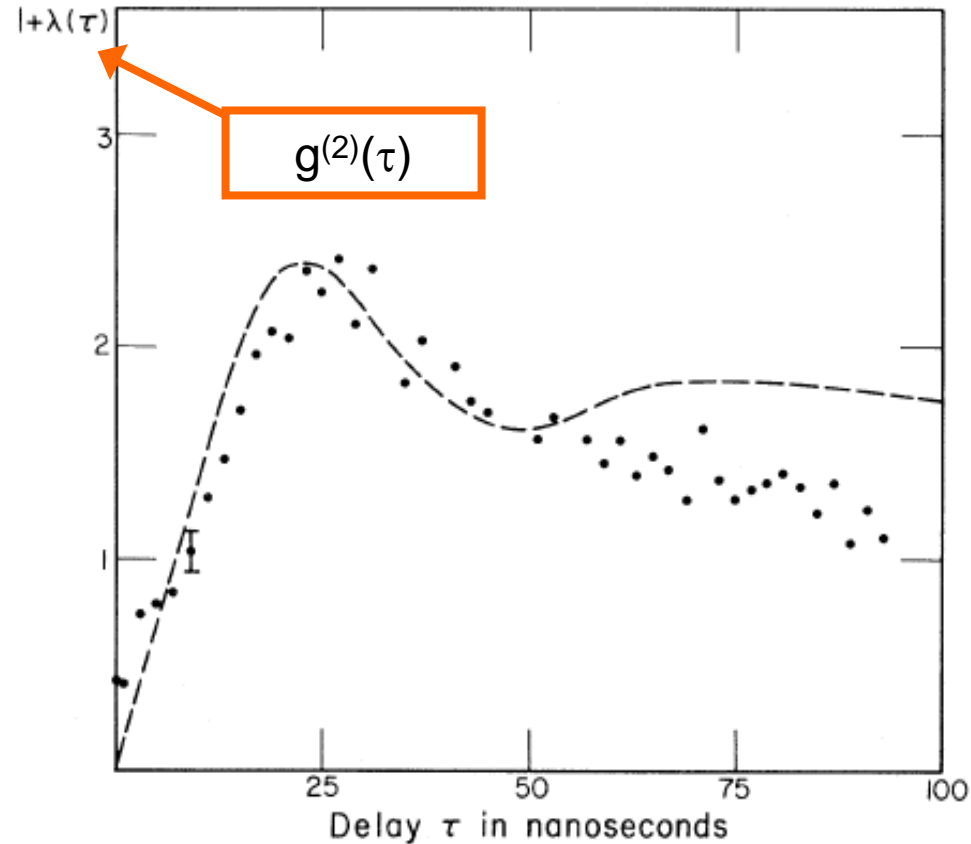
[figure adapted from G. Goldhaber et al., “Influence of Bose-Einstein Statistics on the Antiproton-Proton annihilation Process”, Phys. Rev. 120, 300 (1960)]

# $g^{(2)}(\tau)$ in Quantum Optics

In 1977, L. Mandel measured  $g^{(2)}(\tau)$  for resonance fluorescence from Na atoms

According to Classical Physics:

$$g^{(2)}(0) \geq 1$$

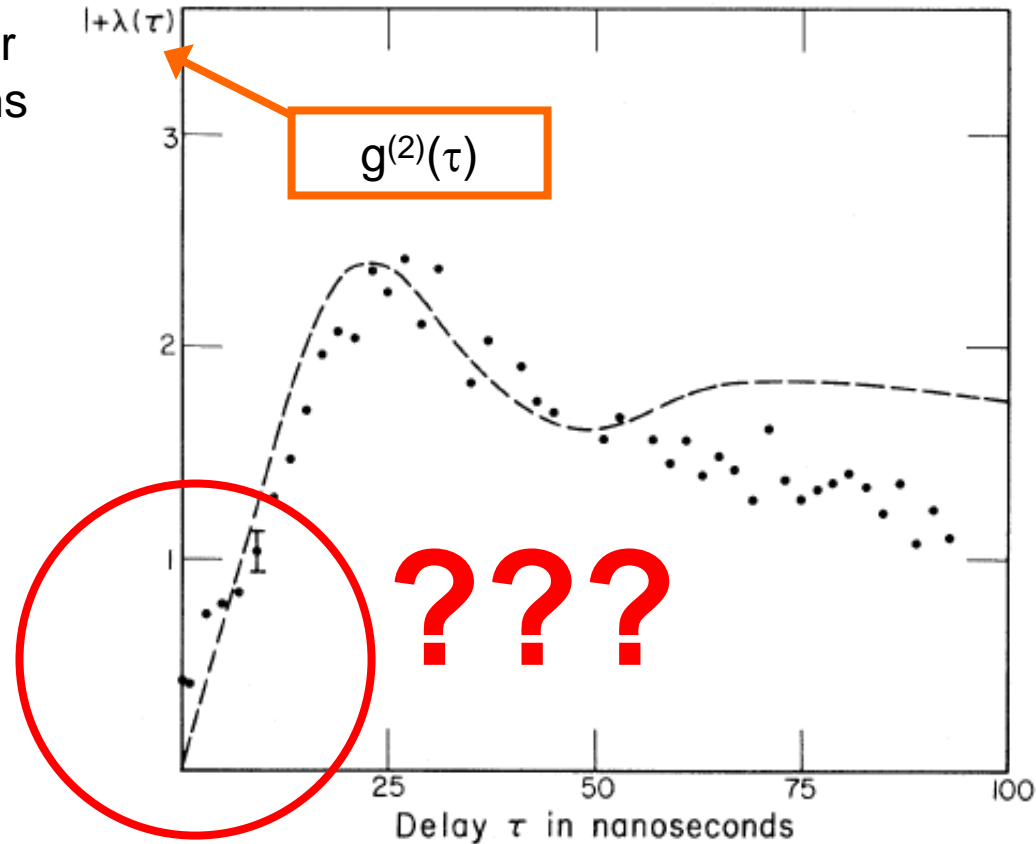


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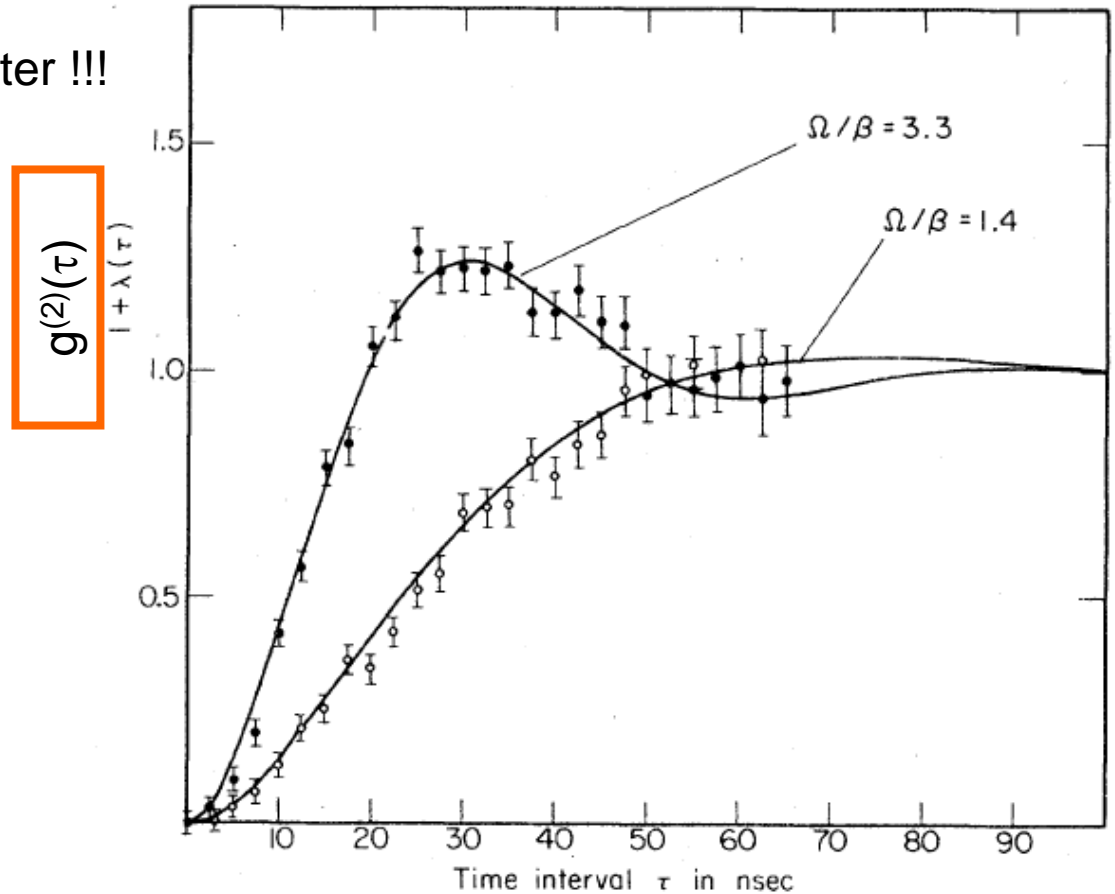


[Kimble et al., "Photon antibunching in resonance fluorescence", *Phys. Rev. Lett.* **39**, 691 (1977)]



# $g^{(2)}(\tau)$ in Quantum Optics

In 1978, the data got even better !!!

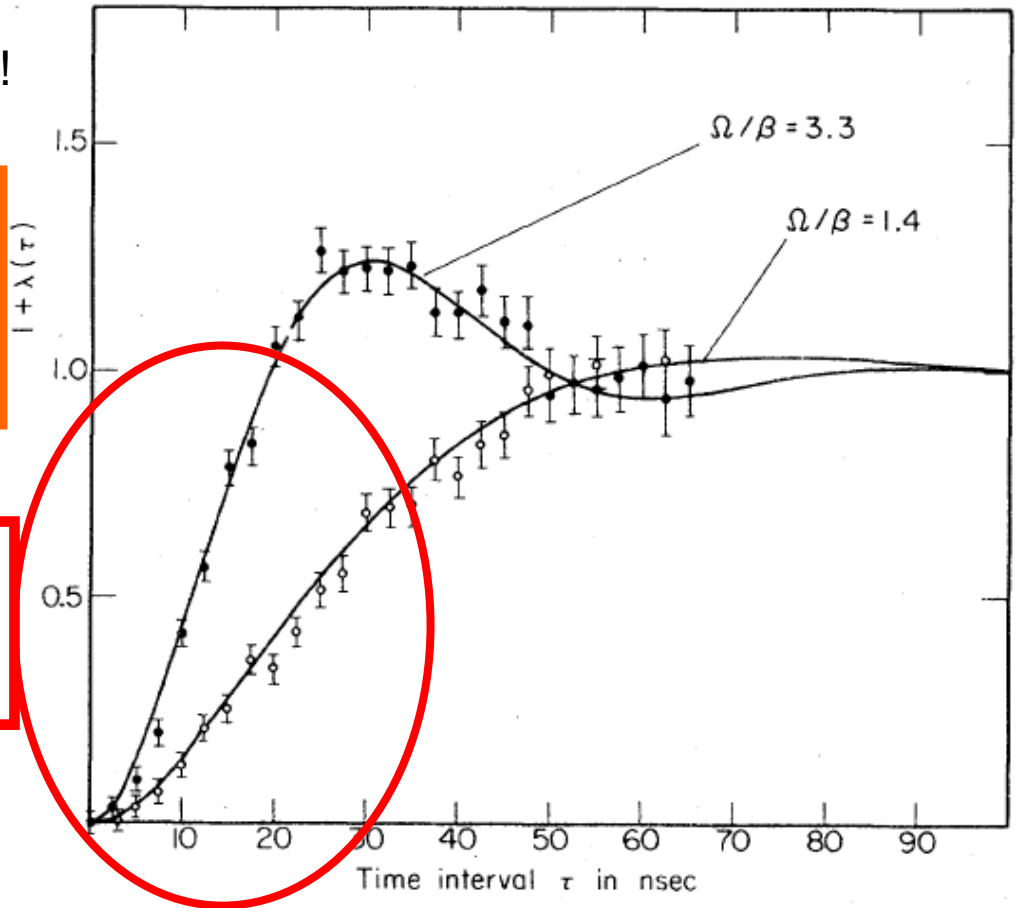


[Dagenais and Mandel, Phys. Rev. A 18, 2217 (1978)]

# $g^{(2)}(\tau)$ in Quantum Optics

In 1978, the data got even better !!!

$g^{(2)}(\tau)$



Non-classical light (quantum light),  
due to quantum aspects of  
fluorescence light.

# 2-level atoms

1. Definition and basics
2. Bloch sphere picture
3. Time-dependence
4. Interactions