Universidad de los Andes | Facultad de Ciencias Departamento de Física

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Entangled Two-Photon Absorption in Molecules

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Abstract

The Two-photon absorption processes (TPA) is currently of great interest due to its variety of technical applications. Two-photon transitions can be excited using light with different properties such as laser light, pseudo-thermal light and entangled photons pairs (ETPA). In particular, the ETPA process has promising applications in different fields due to its linear dependence with the photon flux. However, results of different ETPA experiments have many questions regarding the difficulty to distinguish an ETPA signal from single photon losses when measuring in organic molecules. In order to understand the characteristics of the ETPA process in molecules, an experimental setup to measure the ETPA cross section in RhB using a coincidence detection scheme is presented. The ETPA cross section can be quantified considering the effects of single photon losses in the experiment and considering parameters that are linear-loss independent.

Entangled Two-Photon Absorption (ETPA)

MOTIVATION

- Linear dependence with the photon flux: Enhancement of the TPA process.
- Possible applications with biological samples.
- New spectroscopic techniques.
- Controversy in ETPA measurements.
- Relation between ETPA cross-section and classical TPA

$$R_{TPA} = \sigma^{(2)}\phi^2 + \sigma_e^{(2)}\phi$$

Why Rhodamine B

Applications on:

- Fluorescence microscopy.
- Flow cytometry of living cells.
- Fluorescence correlation spectroscopy.

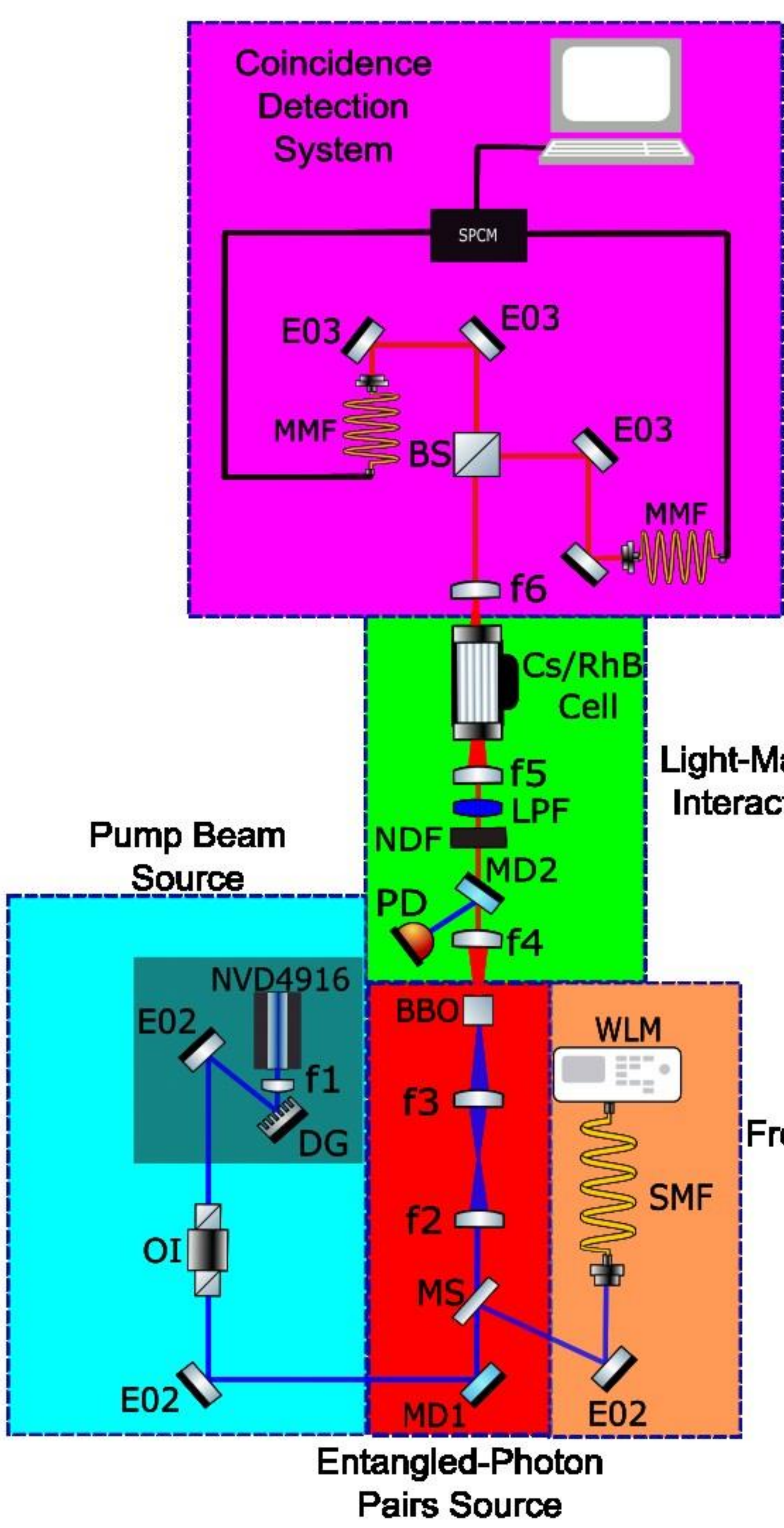
$$\sigma_e^{(2)} \propto \frac{\sigma^{(2)}}{A_E T_E}$$

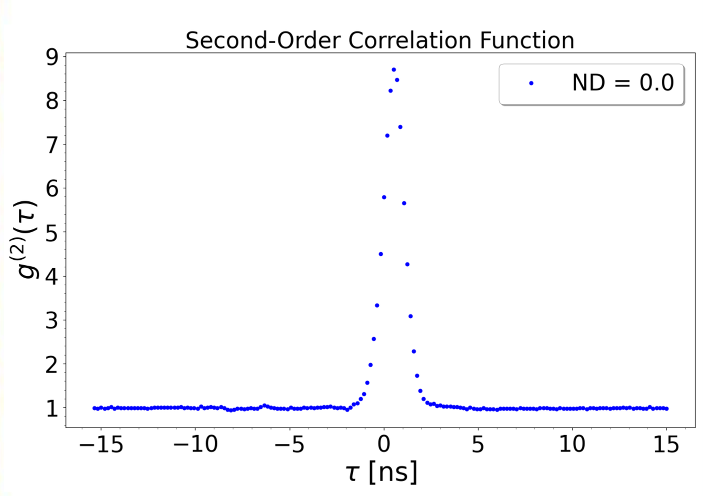
Experimental Setup

Light Source: Entangled-photon pairs Type-I SPDC

Molecular system RhB

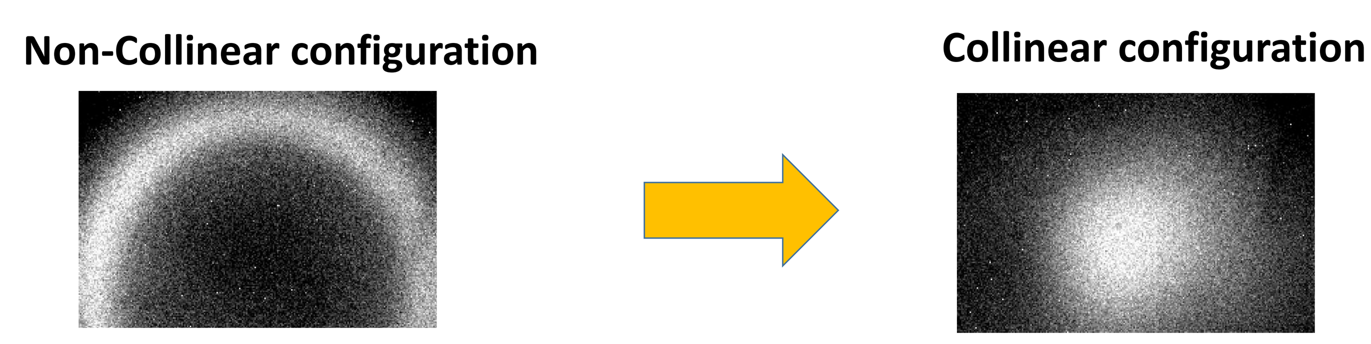
Detection system Coincidence rate





- Photon pairs generated from a Type-I BBO crystal.
- Transmission measurements with coincidences.
- Sensitive to single photon losses.

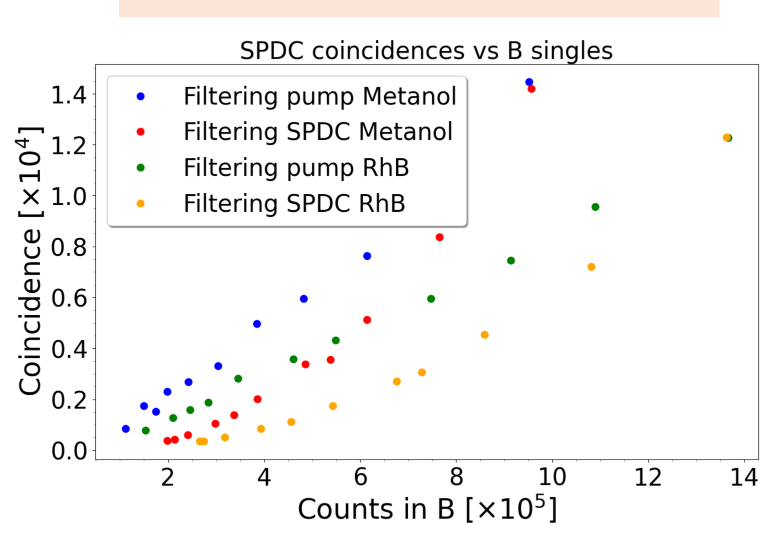
Entangled-Photon Pairs Characterization



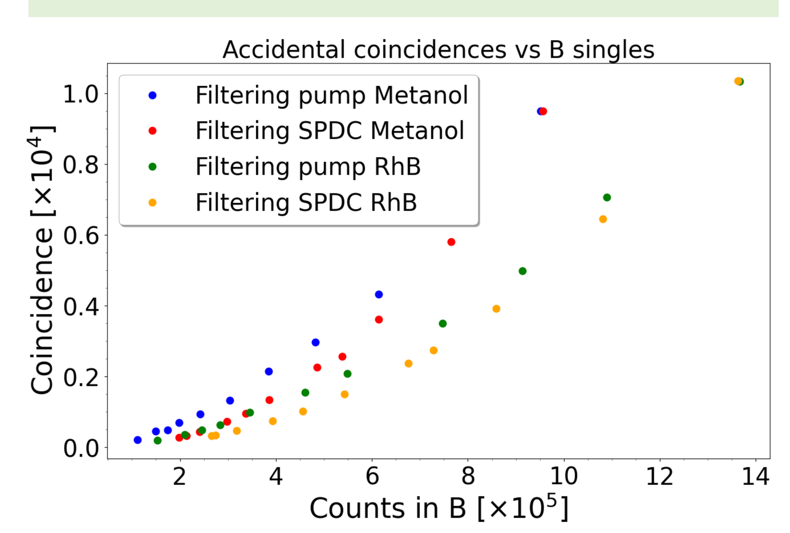
$$g^{(2)}(\tau) = \frac{R_{AB}(\tau)}{\tau_{coin} R_A R_B}$$

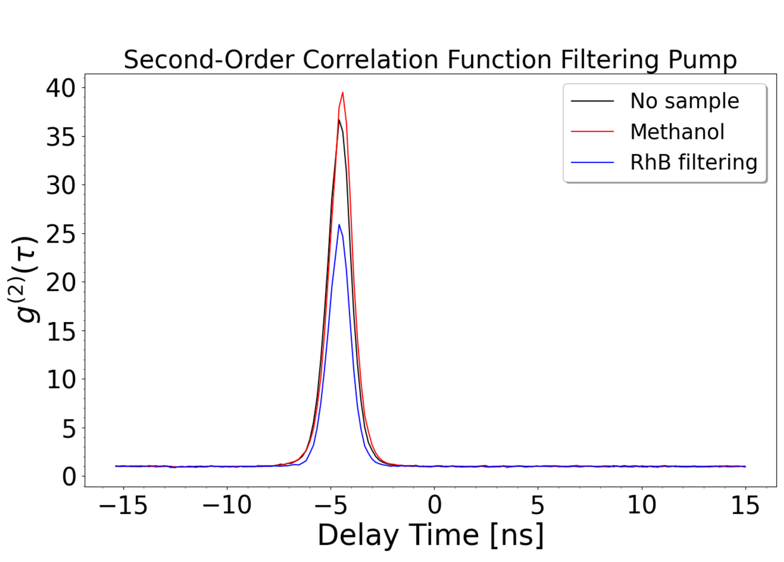
ETPA Cross-Section of Rhodamine B

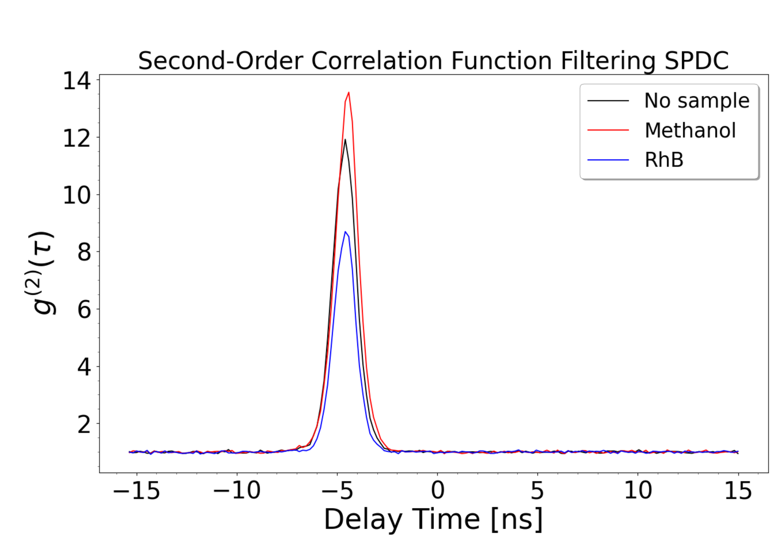
SPDC coincidences



Accidental coincidences







$$R_{TPA} = \frac{cVN_A\sigma_E}{A} R_{solv}$$

$$\Gamma_0 = 1 - \frac{(R_1^{samp} R_2^{samp} / R_{12}^{samp})}{(R_1^{solv} R_2^{solv} / R_{12}^{solv})}$$

Conclusions and Future Work

- We were able to implement an experimental setup to measure the ETPA cross-section of RhB by means of a coincidence detection scheme.
- We can quantify the EPTA cross-section by considering single-photon lossess in our measurements.
- A new experiment regarding ETPA in cesium is planned for the next months.

References

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