# Contactless photon-photon interactions

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The experimental demonstration of electromagnetically induced transparency (EIT) involving highly-excited Rydberg atoms [1] opened gate to a new field of non-linear quantum optics based on dipolar interactions [2]. A unique feature of Rydberg quantum optics is the ability for photons to interact without ever being in the same medium. Recently, we demonstrated the van der Waals repulsion between two photons stored in two media separated by 15 times the optical wavelength [2]. Effectively each photon sees a position dependent refractive index gradient created by a photon in the nearby medium, as illustrated in the Fig. 1.

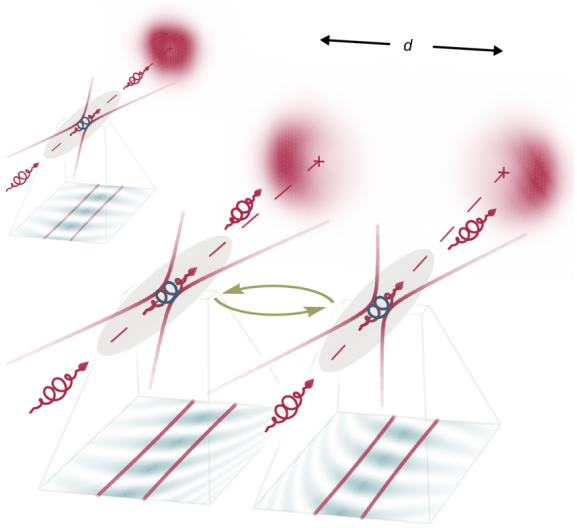


**Fig. 1:** Propagation of light (red) through two independent media (grey). The light couples to highly-excited Rydberg states which interact via long-range van der Waals interactions imprinting a phase gradient (shown below) leading to a deflection of the outgoing light. The inset shows the case of a single channel.

Such long-range interactions between photons provide an interesting platform for scalable multichannel photonic devices, or quantum simulation of strongly correlated many-body dynamics using light.

## References

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[3] H. Busche, P. Huillery, S. W. Ball, T. Ilieva, M. P. A. Jones and C. S. Adams, *Contactless nonlinear optics mediated by long-range Rydberg interactions*, Nature Phys. doi:10.1038/nphys4058 (2017).

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