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Kaveh Bazargan

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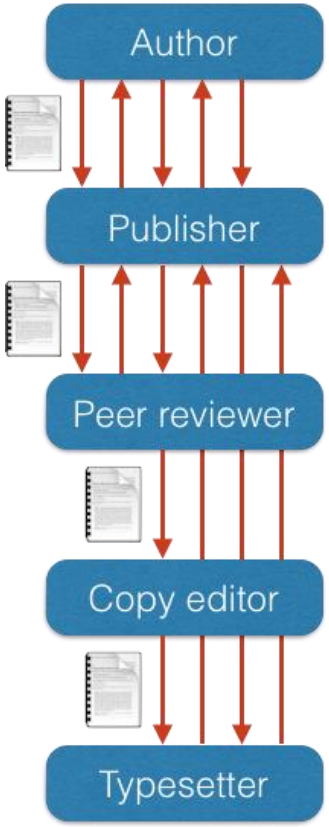

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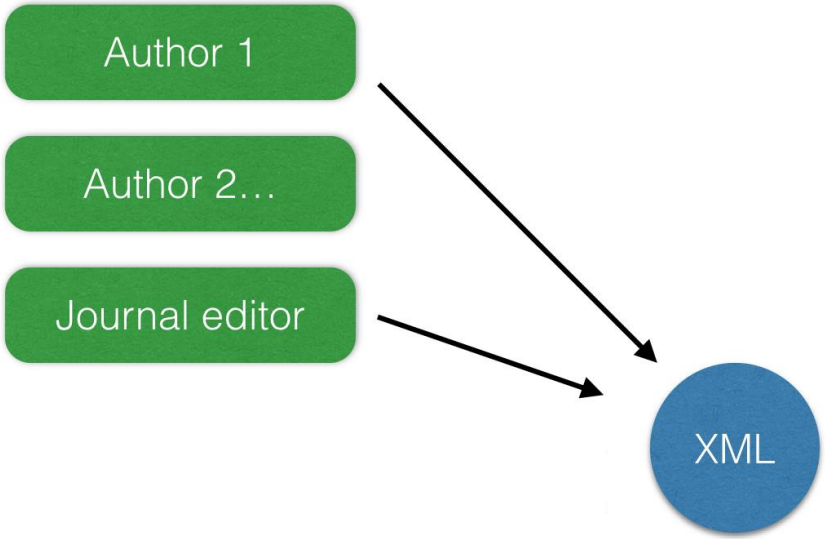

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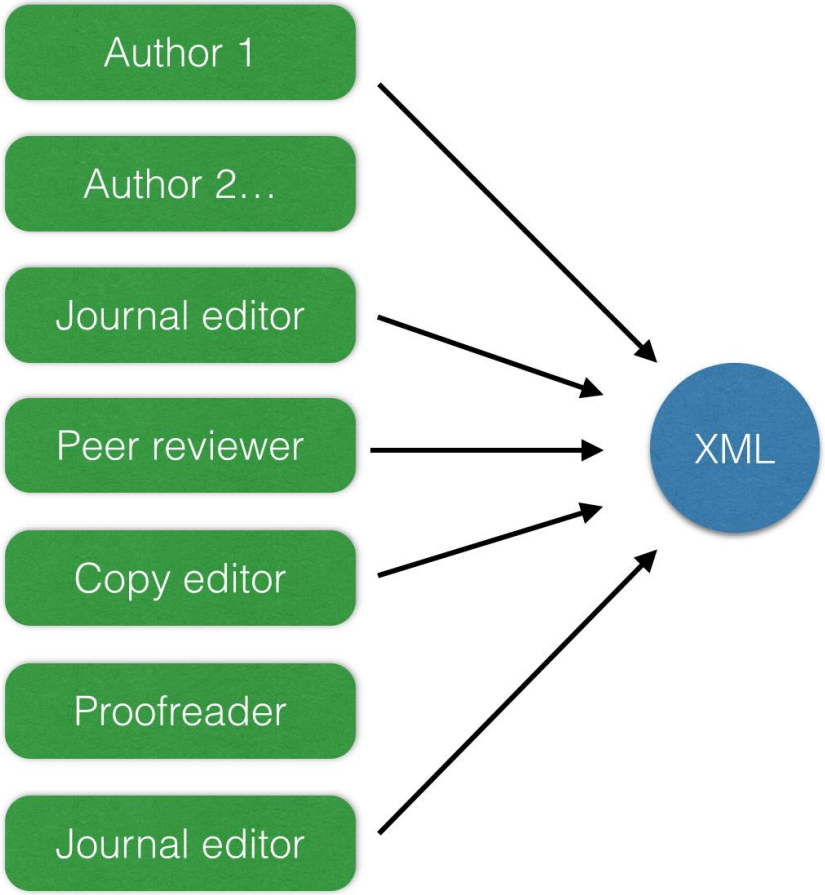

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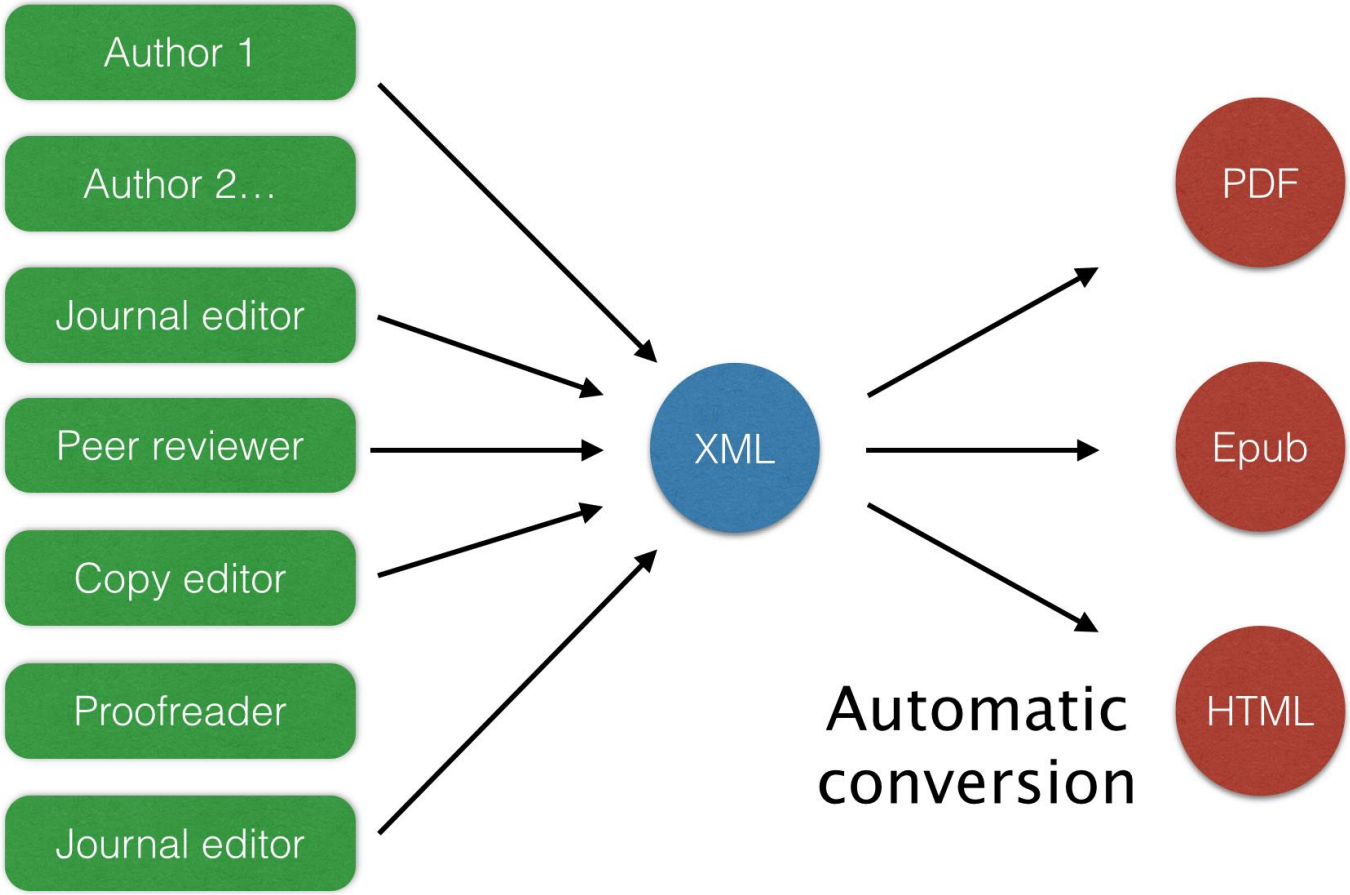

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transistor had a low gain of only 0.24 [7]. Yet many devices, such as amplifiers and repeaters, work by feeding the output of one transistor into the input of another transistor.

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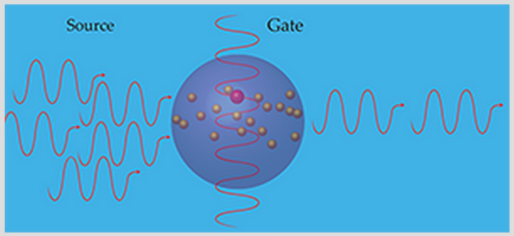
The key to achieving gains above unity is creating strong photon-photon interactions. To make these interactions, the single-photon transistors demonstrated by the Rempe and Hofferberth groups rely on optically excited atoms in high-excitation states, called Rydberg states, and an effect called Rydberg blockade that occurs in clouds of identical atoms. An atom excited to a Rydberg state has a large electric dipole, which induces shifts in the energy levels of neighboring atoms within a so-called "blockade radius." As a result, these neighboring atoms become opaque or transparent to a subsequent light source, depending on how this source's wavelength is tuned relative to the light that excited the Rydberg atom. This interaction persists within a so-called "blockade radius," within which other Rydberg excitations are prevented from occurring (Fig. 1). The Rydberg blockade effect accordingly mediates a strong interaction between the excitation photon and the source photons.

FIG. 1. A photon transistor uses a light source to modulate a medium's opacity to subsequent photons. To make a medium whose opacity can be switched with a single photon, researchers used highly excited atoms in an atom cloud. When an incoming photon (red) excites an atom to a Rydberg state (red sphere), the excited atom perturbs the atoms within a certain "blockade radius" (purple volume) rendering them either opaque or transparent to a subsequent light source.



The interaction between two Rydberg atoms can be many orders of magnitude larger than

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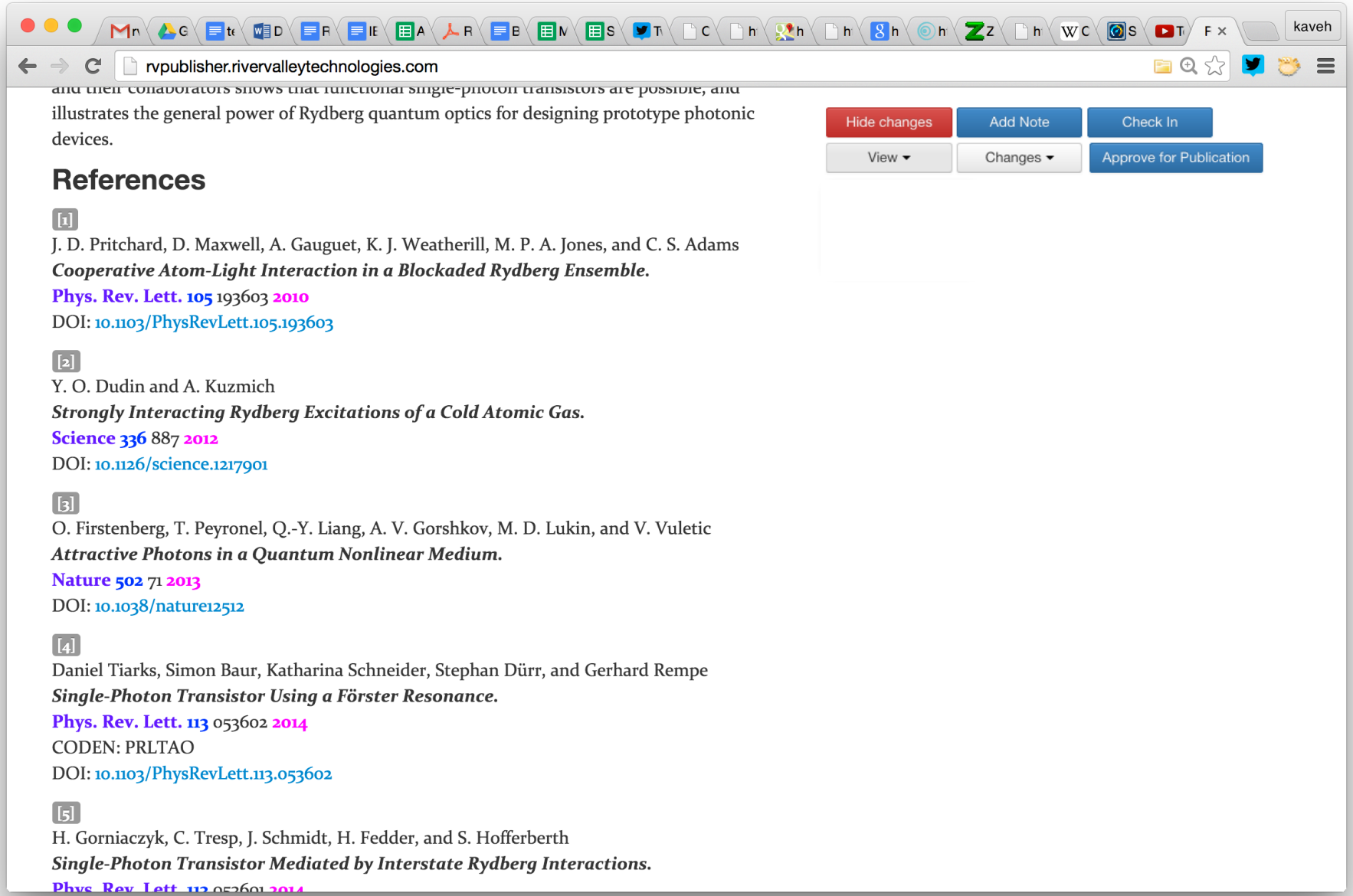

and their collaborators shows that functional single-photon transistors are possible, and illustrates the general power of Rydberg quantum optics for designing prototype photonic devices.

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Single-Photon Transistor Mediated by Interstate Rydberg Interactions.
Phys. Rev. Lett. 112 052601 **2014**

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Added bold

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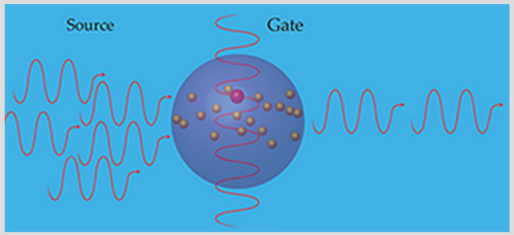

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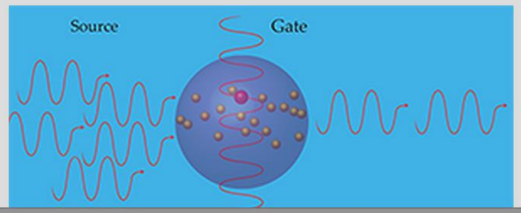

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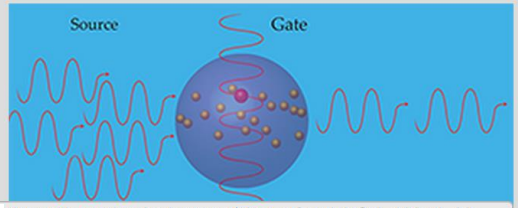

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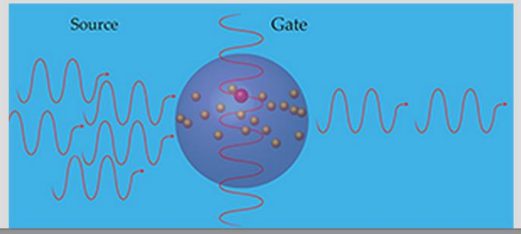

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River Valley Research **7**, 7 (2014)

Review

Statistical flickers in a Bose-Einstein Condensate of Photons Phonons

Cristiano Ciuti
Laboratoire Matériaux et Phénomènes Quantiques,
Université Paris Diderot et CNRS, Paris, France

Published January 21, 2014

Experiments with photons show that the number of particles in a Bose-Einstein condensate can have strong fluctuations.

Subject Areas: **Optics, Statistical Physics**

Summary of:
Statistical flickers in a Bose-Einstein Condensate of Photons Phonons
Journal Info – January 21, 2014

The most familiar type of Bose-Einstein condensate (BEC) is one software writer text added made of identical atoms, which, when cooled to extremely low temperatures, collectively fall into the same single-particle quantum state and form a giant matter wave. But BECs can form from other types of ***bosons*** , including polaritons and photons, and unlike atoms in an isolated trap, these particles can be easily created or destroyed within the medium in which they are produced. Researchers have now revealed unusual statistical effects in a BEC that can exchange particles and energy with such a medium. Julian Schmitt and colleagues at the University of Bonn, Germany, produced a BEC of photons within a bath of photoexcitable dye molecules that acted as a "reservoir" of photons and a heat bath, showing that particle fluctuations in the condensate could be a substantial fraction of the total number of particles [1]. Their experiment, reported in *Physical Review Letters*, is a rare example of a quantum gas in the so-called grand-canonical ensemble of statistical physics. Their work also shows that it served and large fluctuations aren't allowed. Similarly, large fluctuations shouldn't occur in a "microcanonical" ensemble, in which both energy and particle number are conserved.

So far, experimentalists haven't seen these ensemble-dependent statistical effects in BECs. One reason is practical: in the case of an atom BEC, the atomic gas has to be isolated from its environment in order to cool it to low temperatures. These BECs are therefore usually prepared in microcanonical ensemble conditions [2]. In principle, it should be possible to see particle fluctuations in the BECs of exciton-polaritons [3] that can occur in solid-state systems. But both the accurate control of the reservoir and a precise measurement of the fast (picosecond-scale) fluctuations have proven difficult. Finally, theoretical work has questioned if it is possible for a BEC to form under grand-canonical ensemble conditions [4].

The Bonn group shows that, in fact, these conditions

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[2] For a comprehensive review with historic insights, see V. V. Kocharovsky, V. V. Kocharovsky, M. Holthaus, C. H. R. Ooi, A. Svidzinsky, W. Ketterle, and M. O. Scully, "Fluctuations in Ideal and Interacting Bose-Einstein Condensates: From the Laser Phase Transition Analogy to Squeezed States and Bogoliubov Quasiparticles," *Adv. At. Mol. Opt. Phys.* **53**, 291 (2006).

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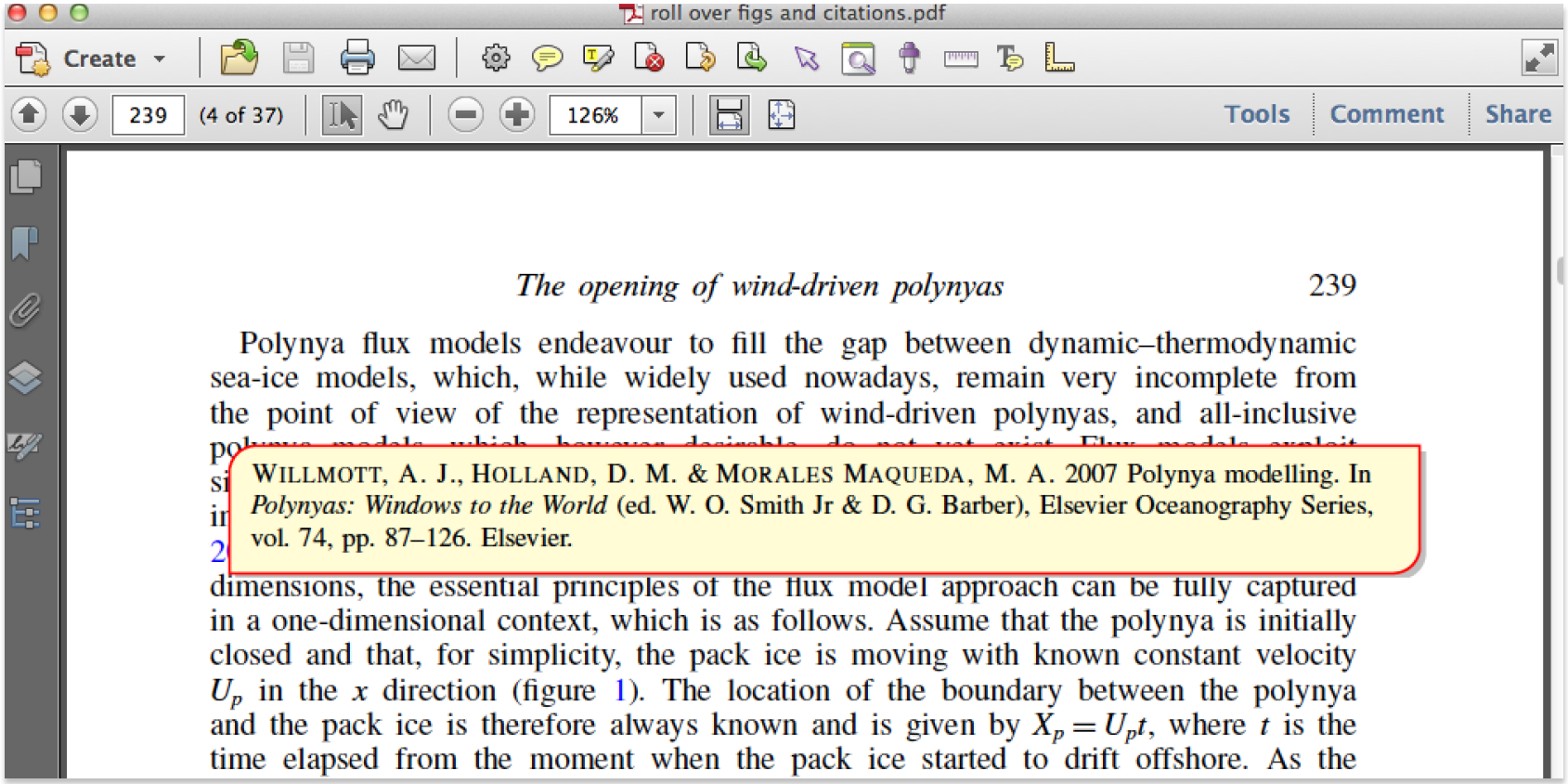

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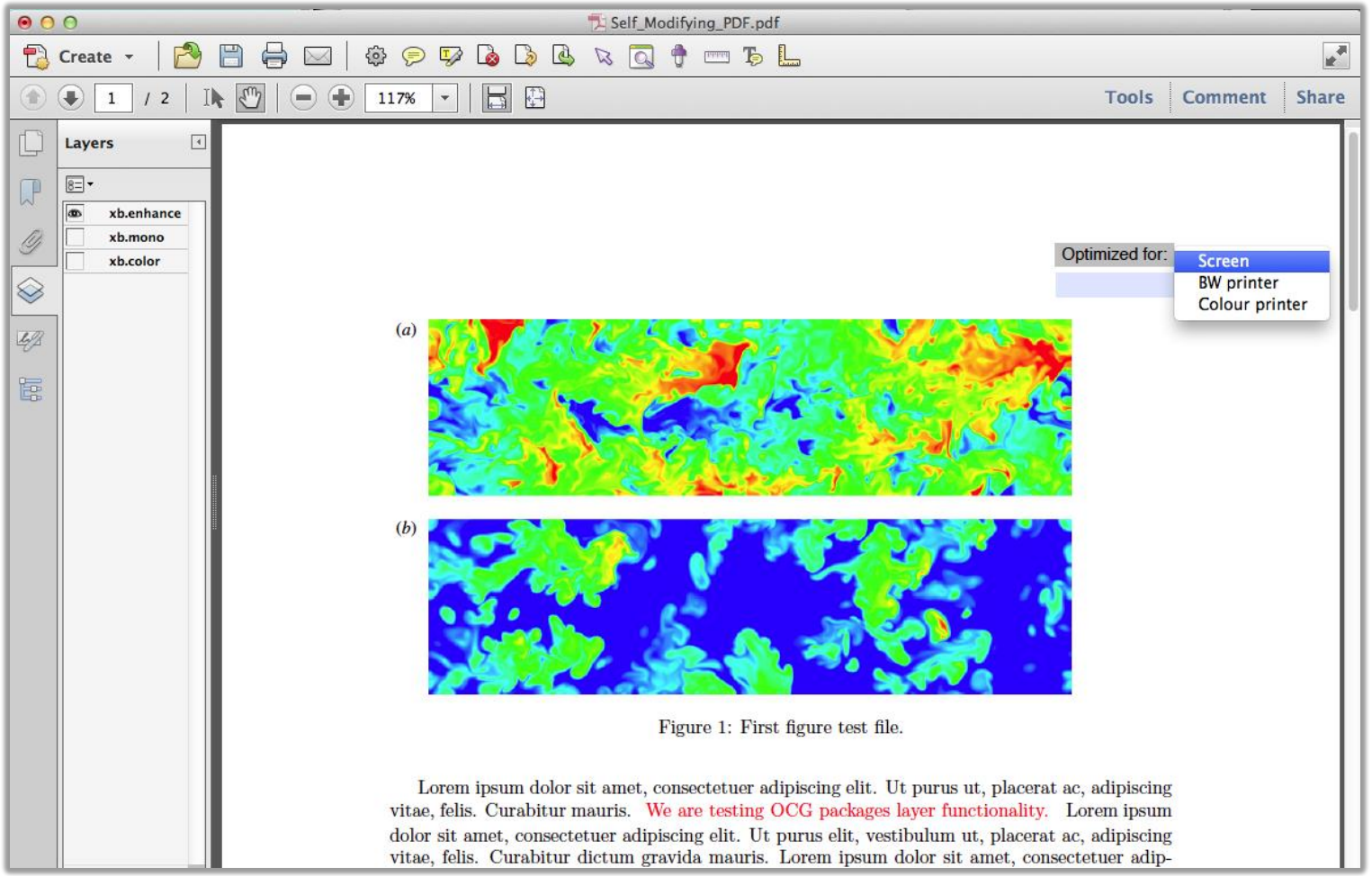

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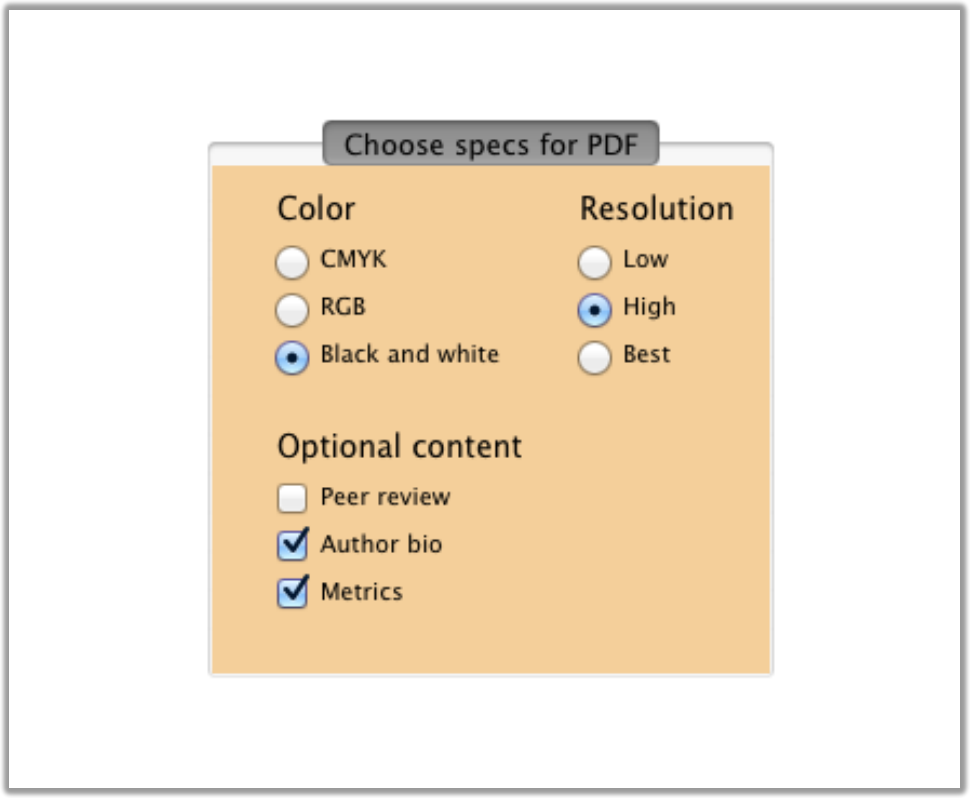

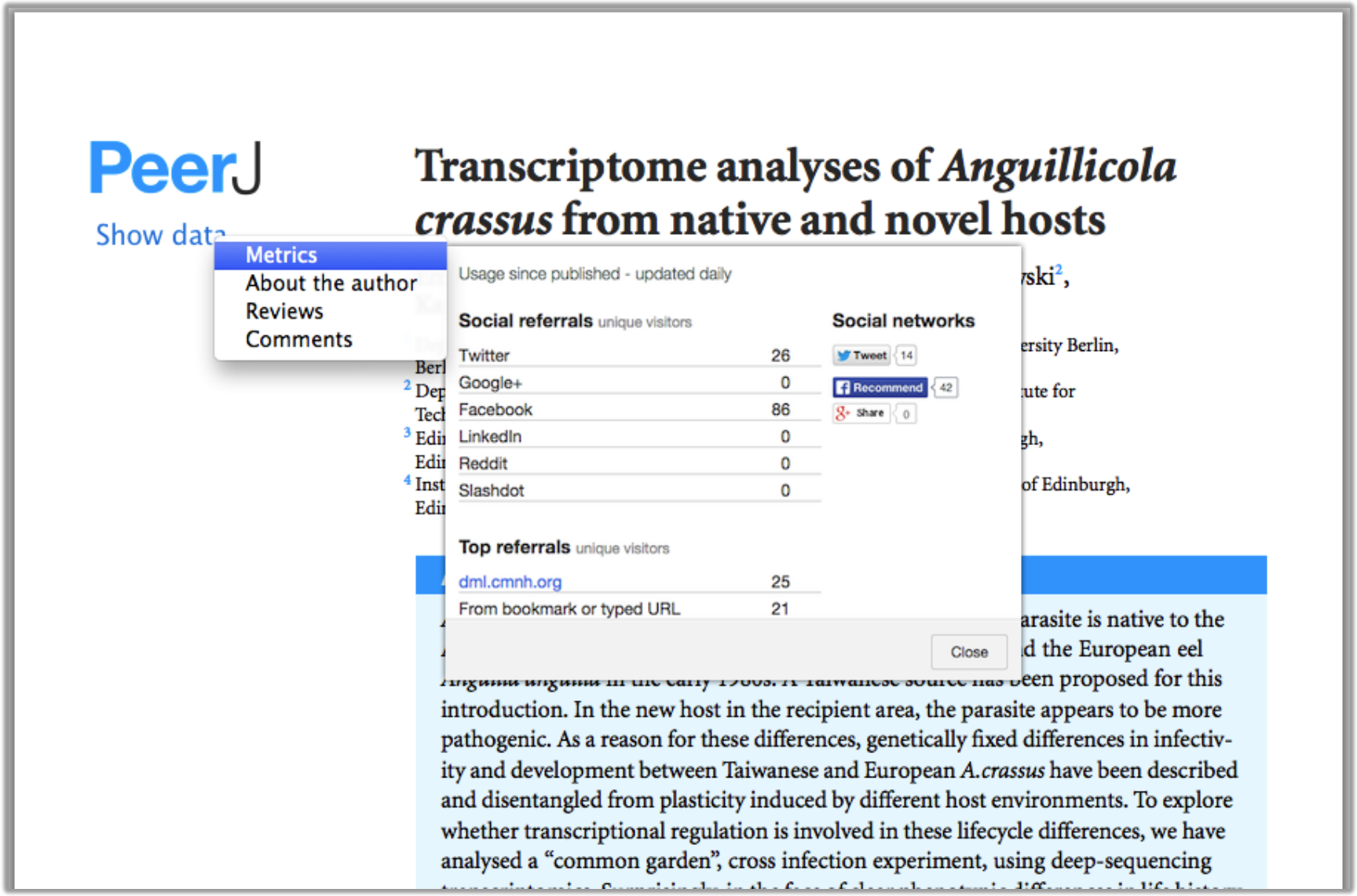
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introduction. In the new host in the recipient area, the parasite appears to be more pathogenic. As a reason for these differences, genetically fixed differences in infectivity and development between Taiwanese and European A.crassus have been described and disentangled from plasticity induced by different host environments. To explore whether transcriptional regulation is involved in these lifecycle differences, we have analysed a "common garden", cross infection experiment, using deep-sequencing

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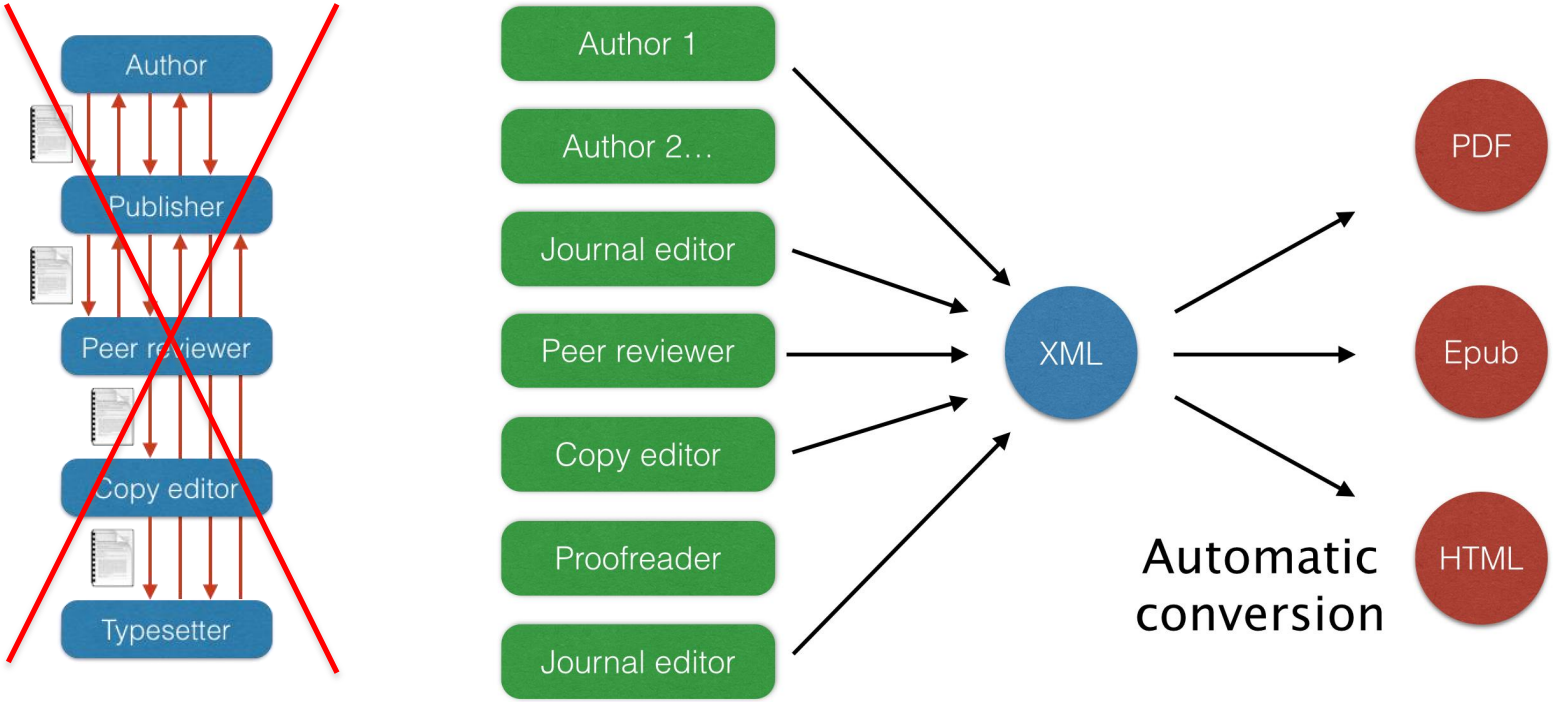

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