Laudatio for the Award Ceremony of the Prix Schläfli Physics 2022 of the Swiss Academy of Sciences (SCNAT) for Dr Natasha Tomm

The Jury of the Prix Schläfli Physics 2022 of the Swiss Academy of Sciences (SCNAT), consisting of Professors Johan Chang (University of Zurich), Ernst Meyer (University of Basel), Ruth Durrer (University of Geneva), Thomas Feurer (University of Bern) and Lesya Shchutska (EPFL) has evaluated excellent applications, and decided unanimously to award the Prix Schäfli in Physics 2022 to Dr Natasha Tomm for pioneering work in quantum photonics, in particular the development of a single-photon source.

Light consists of quantum particles, photons. Single photons play a crucial role in quantum technology – each photon represents a quantum bit, a qubit. Crucially, photons can be used to send the information encoded in a qubit over large distances, via optical fibres for instance. It is a major challenge in quantum science to create a single-photon source, a light source which emits photons one-by-one. The traditional approach exploits a weak process in certain solid-state materials: occasionally a laser-photon spawns two photons, which head off in different directions. This process does not create photons on demand. In principle, this major drawback can be remedied by using instead of a solid-state material a single two-level atom: on decay to the ground state, an excited atom produces one and only one photon; a subsequent photon is then created by re-exciting the atom. In practice, this concept is challenging to implement. Making the implementation even more demanding, contemporary applications pose a further constraint: the photons should all be identical to each other. This can only be achieved if the single atom is hosted in a noise-free environment. Dr Tomm succeeded in creating a single-photon source using this concept. Dr Tomm's approach was to replace a real atom with an artificial atom, a quantum dot in a semiconductor. To ensure that all the photons head off in one particular direction, the quantum dot was embedded in a specially-designed, highly-miniaturised cavity. Despite the novelty of this approach, the single-photon source has an unprecedentedly high end-to-end efficiency, above 50% for the very first time. Crucially, the photons are highly identical: photon-photon interference experiments show very high visibilities even on interfering photons created far apart in time. These results were published in one of the Nature-family journals (N. Tomm et al., Nature Nanotechnology 16, 399 (2021)). The work has led to a new platform with which single photons and also more complex quantum states of light, entangled strings of photons, can be created. It will have a powerful legacy in the burgeoning field of quantum photonics.

Dr Tomm graduated with a BSc degree in Physics at Universidade Estadual de Campinas, Brazil in 2014, and an MSc degree at Friedrich Alexander Universität, Erlangen-Nürnberg, Germany in 2016. Dr Tomm completed a PhD at the Department of Physics, University of Basel under the supervision of Professor Richard J. Warburton in 2021.

Prof. Johan Chang, president of the jury of the Prix Schäfli 2022 and of the Swiss Physical Society

Award Ceremony, Fribourg, 28 June 2022