Quantum Waves at IESL, From the Fundamental to the Practical

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ABSTRACT

Ever since its inception at the beginning of last century, Quantum Mechanics has been at the forefront of the development of modern physics leading to many technological breakthroughs such as laser surgery, micro-electronics, and novel drugs. Arguably, these advances only used Quantum Mechanics to understand existing natural phenomena.

It is only now that we are starting to use and manipulate quantum mechanics itself: Macroscopic quantum states are created, atoms are in multiple places at the same time etc. This can be used for measurements of extreme precision, e.g. for gravitational waves, oil and gas search and even changes in water levels due to global warming.

In my talk, I will present the ongoing research at IESL to employ quantum phenomena like particle-wave duality and matter-wave optics to perform atom interferometry both on Earth in matter-wave guides [1] and in space. As an example, figure 1 and 2 show photographs of atoms in our novel ultra-smooth matter-wave guides [1]

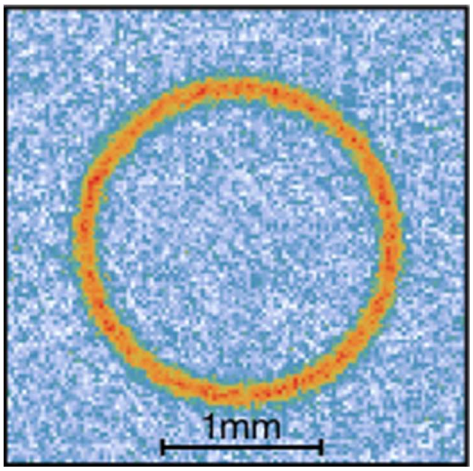

Figure 1: A false-colour photograph of less than one million atoms in a ring-shaped trap. The temperature of the atoms is only one hundred nano-kelvin above absolute zero. The atoms are forced into this ring-shape by magnetic potentials with pico-Kelvin level control [1]

REFERENCES

[1] *Hypersonic Bose--Einstein condensates in accelerator rings* Saurabh Pandey, Hector Mas, Giannis Drougakis, Premjith Thekkeppatt, Vasiliki Bolpasi, Georgios Vasilakis, Konstantinos Poulios, and **Wolf von Klitzing** ***Nature*** **570:7760** 205--209 (2019).

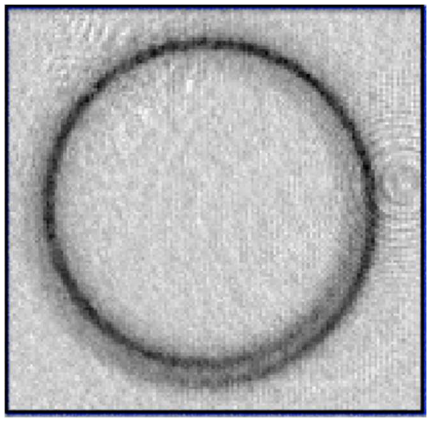

Figure 2: A spirally-shaped Bose Einstein Condensate where atoms are delocalized over a distance of more than 4mm.