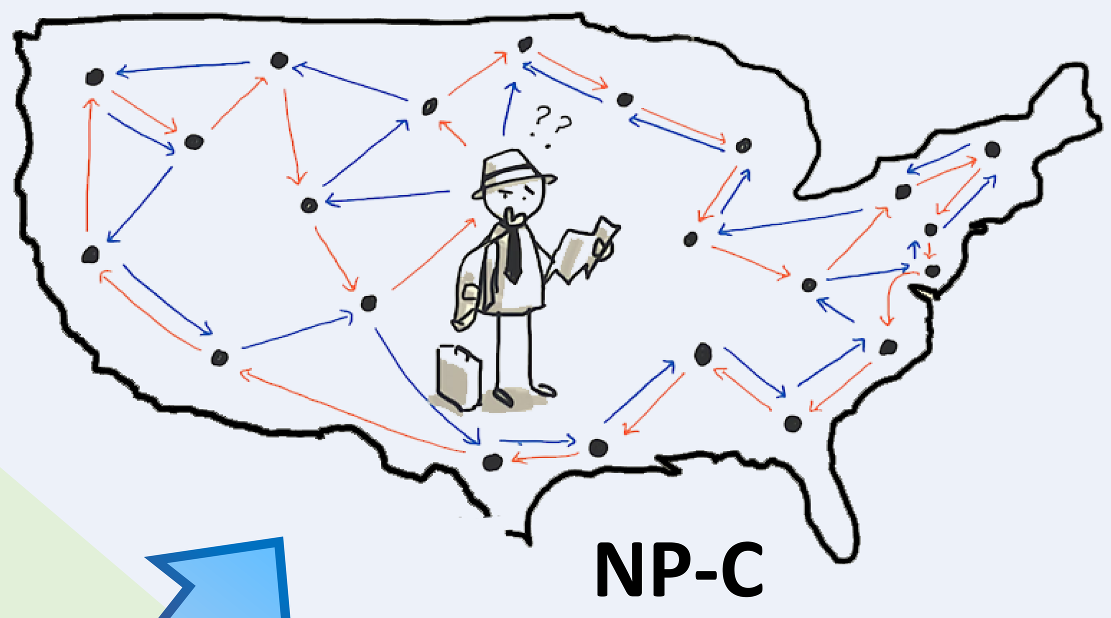
In-Situ Coherence Tuning of a Network of Photon Bose-Einstein Condensates

Introduction

Finding the **ground state** of a physical system such as a network of coupled photon Bose-Einstein Condensates **(pBECs)** is a Nondeterministic Polynomial Complete **(NP-C)** or, in other words, a hard problem.

Traveling salesman wants to visit all towns in shortest possible time and return to the initial town.

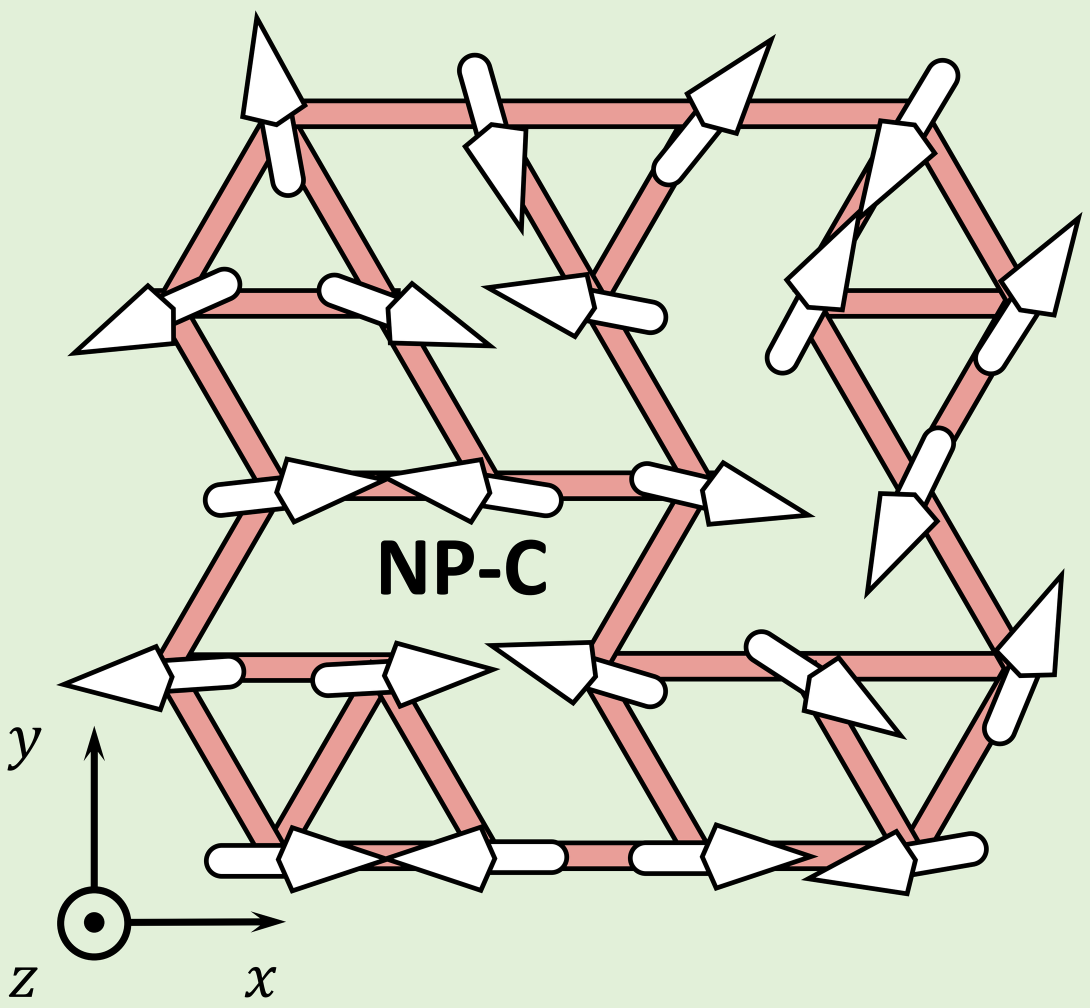


If a solution to one of the problems from NP-C class is found, then a solution to **any** other problem from this class can be acquired by **remapping** it to already solved one.

A problem can also be mapped to a **physical system** that solves it by thermalizing to its **ground state**. This state's configuration is then mapped back to acquire the solution to the original problem.

Methods

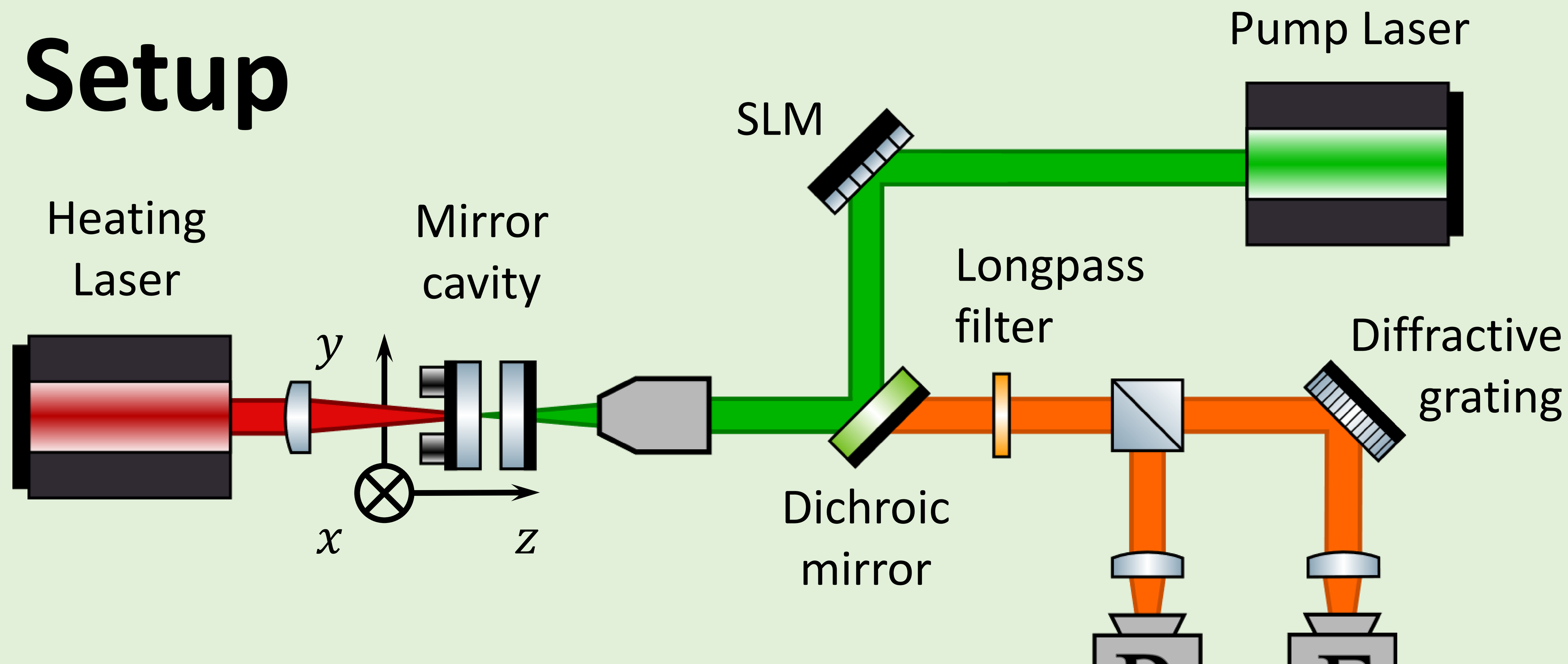
Nearest neighbor interactions between pBEC's are defined by the shape of connecting waveguides.



It is crucial that all sites act as **coherent sources** even in absence of connecting waveguides. In general, this is not true due to **mirror roughness** and its **non-flat profile**.

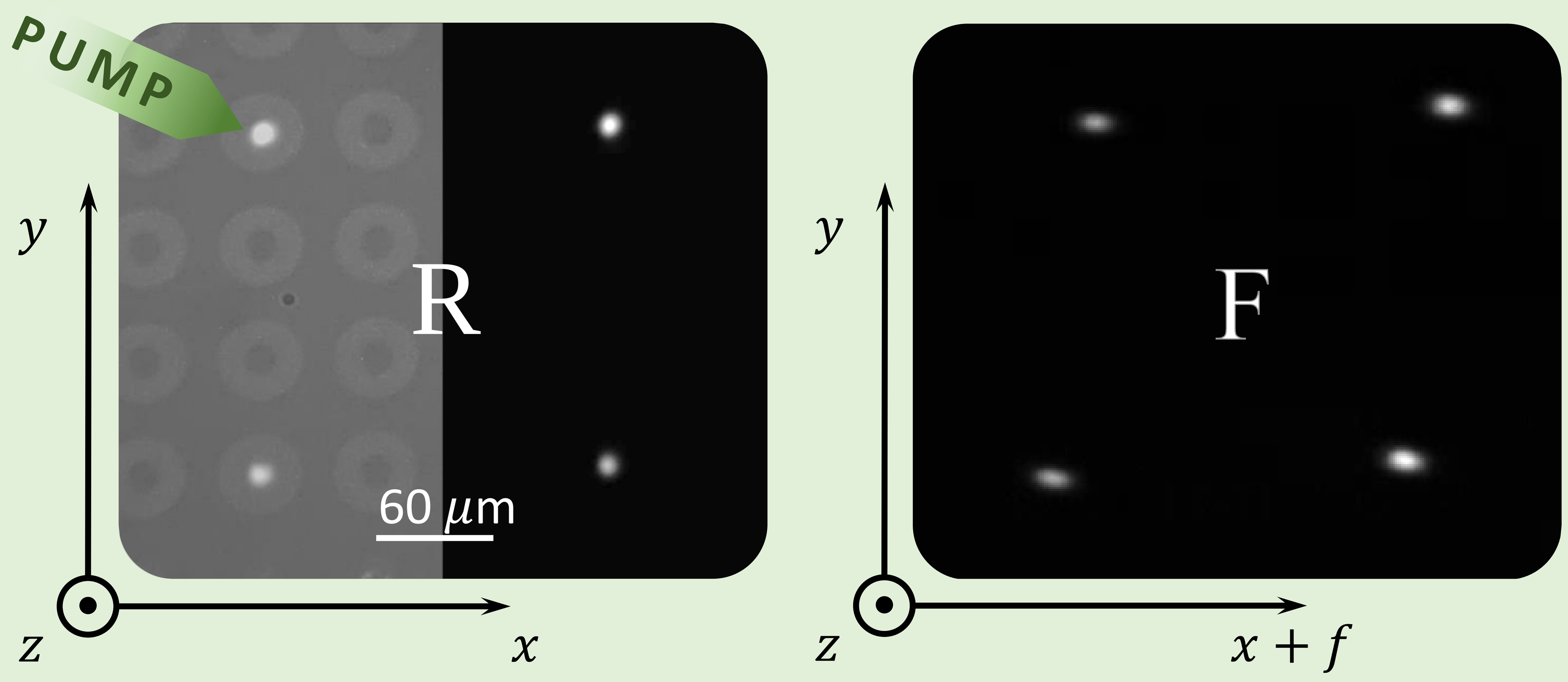
We investigate our capabilities to create such sources by employing the same **nano-structuring technique** that is used to create permanent structures on our mirrors.

Setup



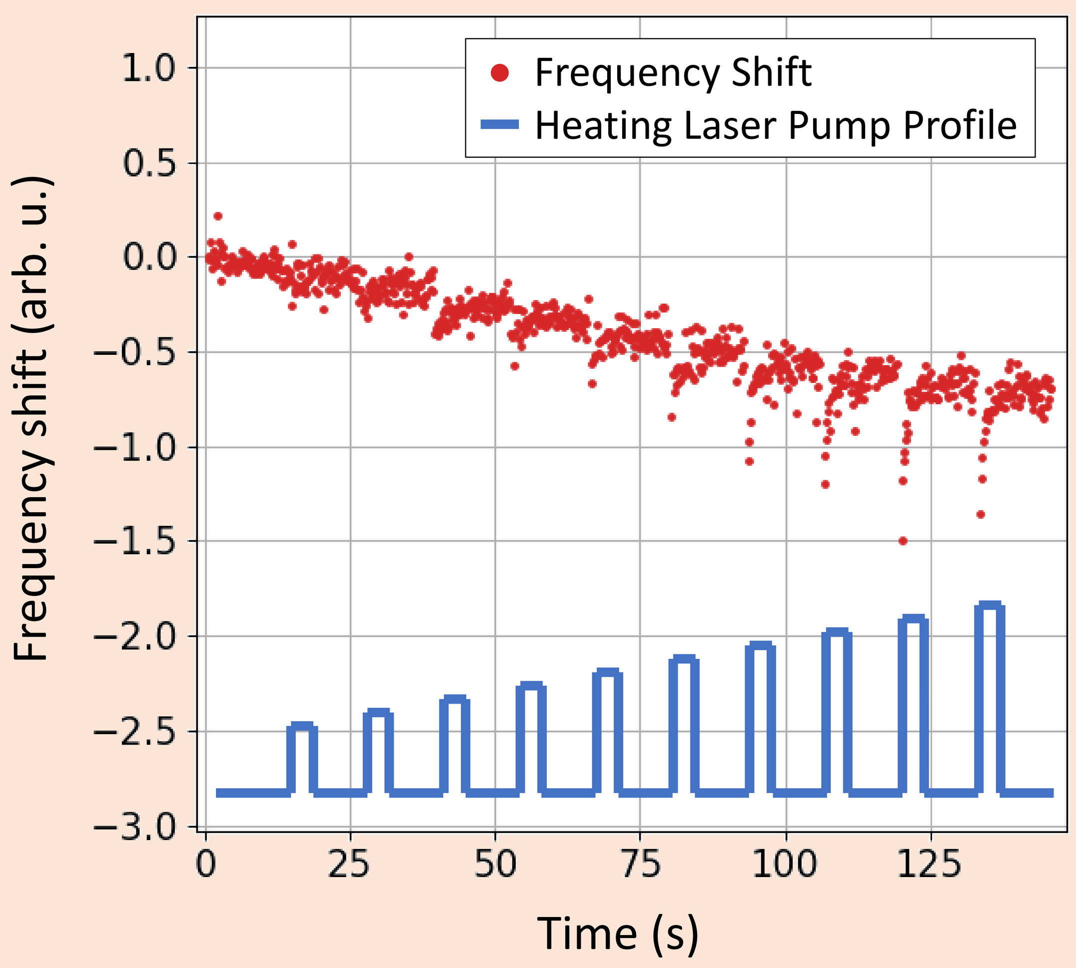
Dye fluorescence is excited by a pump laser and is **spectrally confined** by the mirror cavity.

At the same time, permanent structures on one of the mirrors **spatially confine** fluorescence of the dye (the leftmost image).



We **track frequency** of fluorescing sites by analyzing signal reflected from the **diffractive grating** (right image).

Results and Outlook



By pumping one of the sites with the **heating laser**, we locally and permanently alter mirror surface which **shifts fluorescence frequency** of one of the sites with respect to the others.

This opens a path to creation of a novel **in-situ approach of one-time frequency tuning** of all condensate sites of a network. Frequency tunning is expected to **improve** coupling **efficiency** and coupling **uniformity** between network sites.

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