

## A BRICK

**Alice Sinatra** – Coherence is a property of waves. A monochromatic wave has a phase that oscillates in time periodically, indefinitely. We can imagine a child skipping rope very regularly, with no interruptions. In the case of a Bose-Einstein condensate, that is a state of matter where many atoms share the same quantum state, coherence is macroscopic. It's as if hundreds of thousands of children were skipping rope together in a perfectly synchronized fashion. But, the atoms interactions can perturb the evolution of the phase, so a question arises: what is the condensate coherence time in presence of interactions. This was already answered for a  $0^\circ$  temperature by a Russian physicist in the 60's. Yet it was an open question at non zero temperature. In the year 2000 two first papers came out about the coherence time of a condensate at non zero temperature. They predicted that the condensate phase does not remain well defined forever: a probability distribution broadens in time, and it broadens proportionally to the square root of the time. It's the velocity with which the condensate loses the memory of its initial phase. A third paper found, but we didn't see it at the time, a very different result. It found that it broadens as a function of time not the square root of time, so much faster!

Afterwards, in 2006, I was in Poland at a conference, and I saw the poster of a young girl in her PhD studies, making classical field simulations to study condensates at finite temperature. I thought it would be a good idea to use classical field simulations to see this effect! So Emilia Witkowska came to Paris and made the simulations. And we were very surprised to see the phase broadening linearly in time, not as the square root of the time. It was not what we expected. It was indeed the third article that we didn't know at the time, which was right. We have studied then the problem in depth, in particular with Yvan Castin, who was following distantly our investigations with Emilia. We saw that even the third article, which didn't miss this point, was not complete. To explain the simulations of Emilia Witkowska, it was necessary to introduce interactions among the quasi-particles. Some years after, we had written a few papers, become friends with Emilia Witkowska, and together with Yvan we felt like contributing with a small brick to the edifice of knowledge.

**2min 50sec**