IN A SINGLE NOTE

Nadia Belabas – My job consists in creating and manipulating quantum entanglement in small systems. Entanglement means weaving links among some magic many-body states, such as those we are learning to assemble by grouping identical specks of light. These entangled states have wonderful applications: they're like the Gibis, the enemies of the Shadoks; they'll solve any problem by putting on their hats, because that puts them in a state where they all think as one.

Since I'm a physicist, thinking of light brings up all the properties that I can measure: its intensity and color; how to guide its direction, and also a feature that makes it become quantal - the way it assembles in little bunches called photons. An assembly of photons is entangled when a specific property of part of the system - its light for a photon, say - is connected to the same property in another part. Measuring one, you get the result for the other without having to measure it. But of course, if I find a red left-hand glove in my drawer, the other red glove (necessarily right-hand) won't be quantum-entangled with its twin. The measuring process doesn't have an immediate effect on the second glove. They were in the same state before I ever touched them! To build a quantum-entangled glove state, you would have to first know how to create so-called "superimposed states", both left- and right-handed. That can only be done with quantum objects, not with gloves. I like to draw entanglement as loops that move around like this.

In the lab, we design them, we build them, we measure them, we make them grow - not an easy thing to do efficiently. Photons have many ways to superimpose their states - being in two places at once, say, or displaying two colors at the same time… - hence being entangled. This behavior is (rather strangely) described in terms of their "degrees of freedom". But in fact, they're definitely individualists, they cross paths but don't interact, they keep going straight on, far away. To make photons useful, to make them play together, the trick is to make them perfectly identical. Once that is done - and it's also a quantum feat -, once you can't know which is which, then you open a realm of possibilities, including photon compensation behaviors and ultimately the emergence of a collective behavior. Yes, photons are turned into sheep… And the aim is to assemble a herd of such entangled sheep.

Now these photons require a resonance cavity, a very efficient exit path. This is done with the very same materials that make up our everyday electronics: good old semiconductors. Ultimately, the devices made right here in our clean-room or at Quandela behave as we wish, meaning like a single atom with just two energy levels under control, or like a nonlinear crystal in a cavity - good providers of sheep. Combining such set-ups with tiny light circuits or photonic microchips, we produce portable quantum logic: pocket entanglement, so to speak… To reach the stage where peaks displayed on a screen prove that everyone - photons and researchers - is well-connected, it's crucial to have identical photons and presumably different researchers, with differing expertise, differing imaginations (and lots of freedom).

We hope to get many, many photons in this way: the more we get, the more we'll be able to work wonders by blending them in a pretty entanglement with our science, our technology and our questions. They're somewhat like music. For me, making music is nourishing the line you sing or play with all the music you've heard before, even the music you've imagined: a note is music, not just a sound, when it's filled with that experience and that dream.

3 min 44 s