UNRAVELING

Vaughan Jones – What gets me excited is when two apparently different interests of mine come together – even better when one interest is scientific and the other is recreational! When I got into kitesurfing about ten years ago this happened in a big way with braids. And not just braids, but the mathematical connection between braids and knots. Let me explain. A knot consists of an infinitely thin, infinitely flexible string, with no endpoints. A link is the same thing except that there may be more than one string. Knots and links are considered up to smooth topological deformation – one may twist, bend and stretch the strings as much as one likes provided one does not cut the strings.

Braids are like links – take two horizontal bars and join them with strings. The defining property of a braid is that, once a string has left the top bar, it keeps on going down, never turning back up. Because of this, braids form what mathematicians call a group, a structure that has a composition law. There is the kite. The person doing the kitesurfing holds a bar and the bar is connected by four lines going to the kite. It's very important that these four lines do not cross! And they have to be connected to the right points on the kite. But for sure they will get themselves into a big mess. When that happens the kitesurfer must turn this tangle into a very simple braid – the identity braid. The identity in a group is the element such that, whenever you compose it with anything else, it doesn't change that other element. We now come to the huge advantage of the group structure of braids – not only is there an identity, but each element α has an INVERSE – that is to say another element α^{-1} so that when one composes α and α^{-1} one obtains the identity. Thus to undo his tangle our kitesurfer has only to apply the inverse braid! Altogether he has made a braid from the tangle he was faced with using an algorithm due to mathematician Alexander, taken the inverse and obtained the identity element. He's now happy and sure his kite is correctly rigged. He can go and play on the water…

But why is one interested in knots and links in science? One example is the DNA molecules in molecular biology. A law of nature known to everyone says that long thin strings will, at the slightest chance, get themselves tied up in a complicated tangle… Thus it is for DNA molecules and it poses a great problem for life. Evolution must have been stuck for millions of years before solving this problem – at the termination of replication the double helix has made two copies of itself but they will be highly linked together. These two daughter molecules have to separate physically from each other since one has to go in this cell and the other in that one! If this problem is not solved, life does not go on. I don't think we fully understand yet how nature has overcome this problem…

3min 54sec