Disordered superconducting thin films

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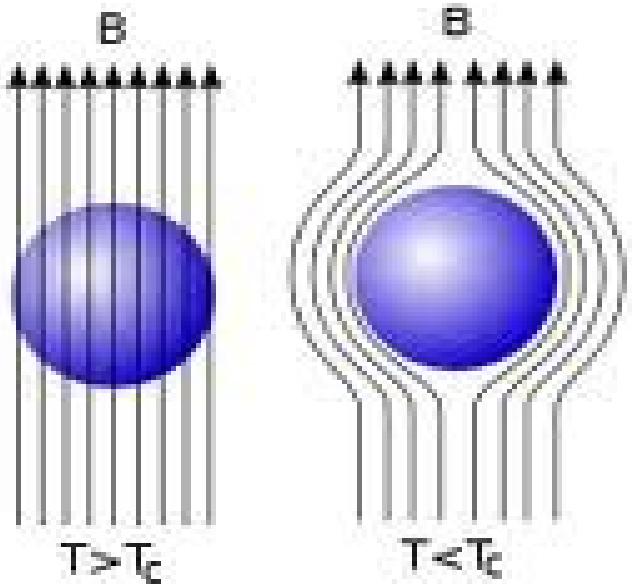
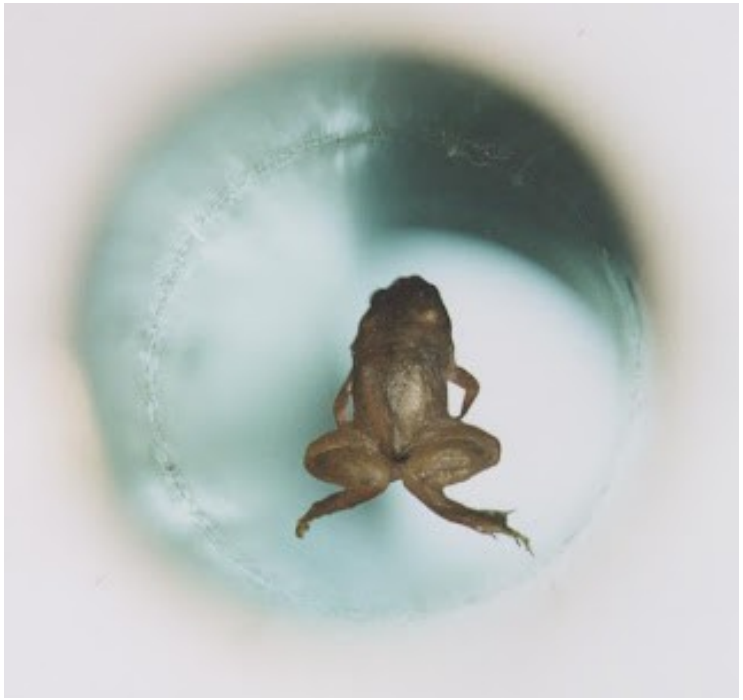
"Thermal phase transition in two-dimensional disordered SCs" - A.E and Y.M, Europhys. Lett. (2010)

Superconductors: diamagnetism. "The Meissner effect"



Can be utilized for levitation:

Levitation can be abused.



This experiment by Andre Geim and Sir Michael Berry won the 2000 Ig Nobel Prize in physics for discoveries "that cannot, or should not, be reproduced"

Geim went on to win the 2010 Nobel Prize in physics together with Konstantin Novoselov for pioneering work on the two dimensional material graphene.

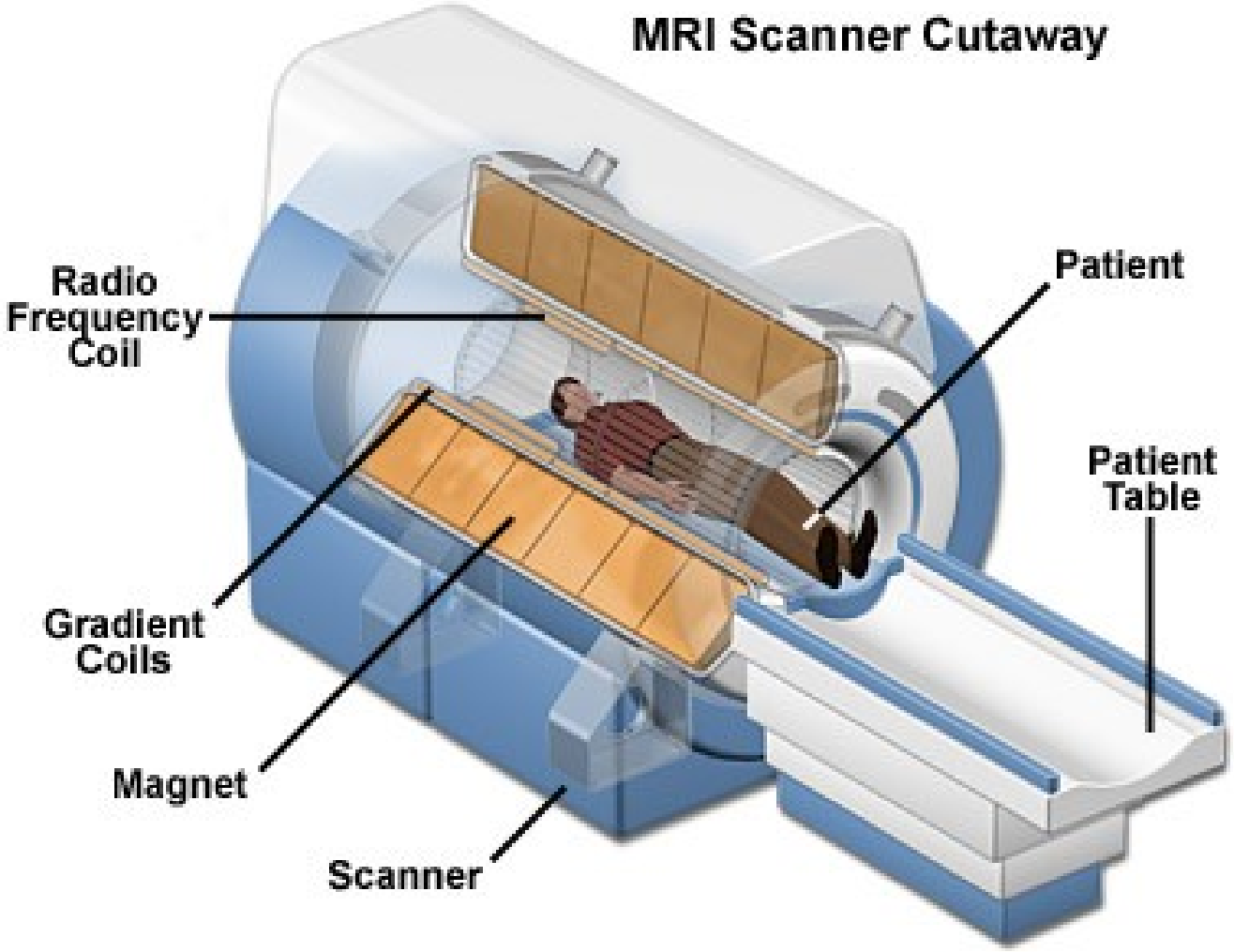
Andre Geim

Konstantin Novoselov

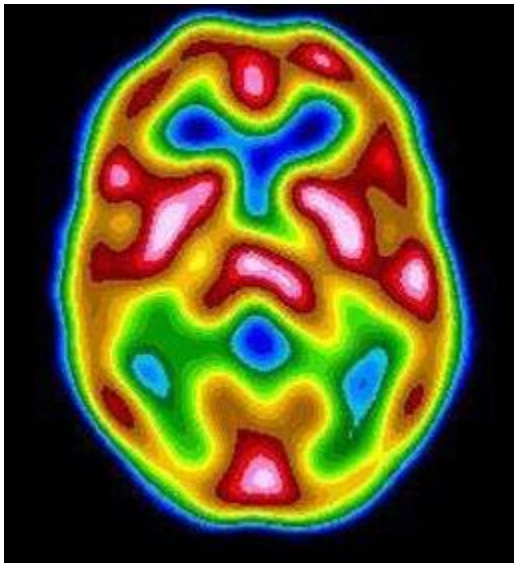
Superconductors allow current flow without resistance.

Approx. 50% of the power on the grid is lost to heat. Room temperature SCs could dramatically improve this.

They make the powerful magnets which are used in MRI scanners

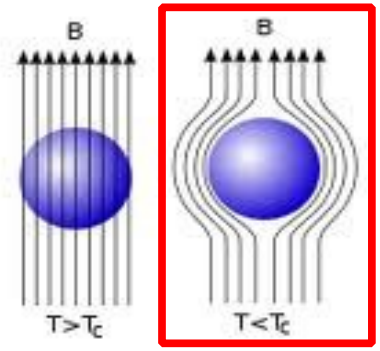


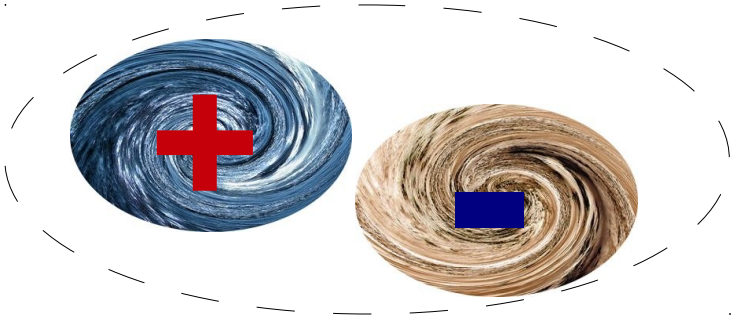
Other uses include SQUID brain scanners.



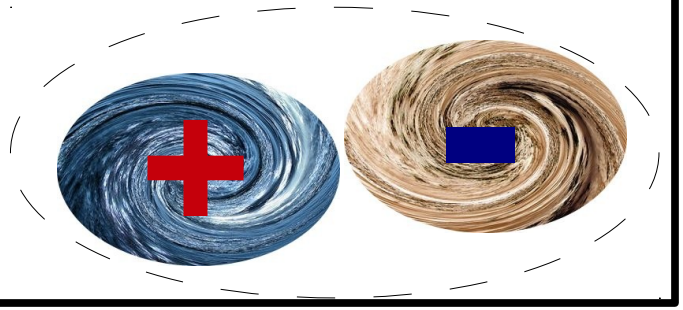
SCs may hold the key to the future of computing. Much research is done to try and build a quantum computer using superconductors.

What happens at Tc in 2d ?
At low temperatures, vortex-antivortex pairs

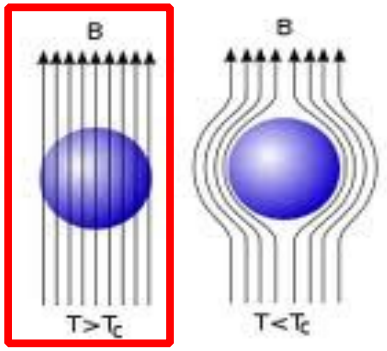




Bound pairs effectively cancel each other



Increasing the temperature,
the pairs unbind and no longer cancel
thereby killing superconductivity.



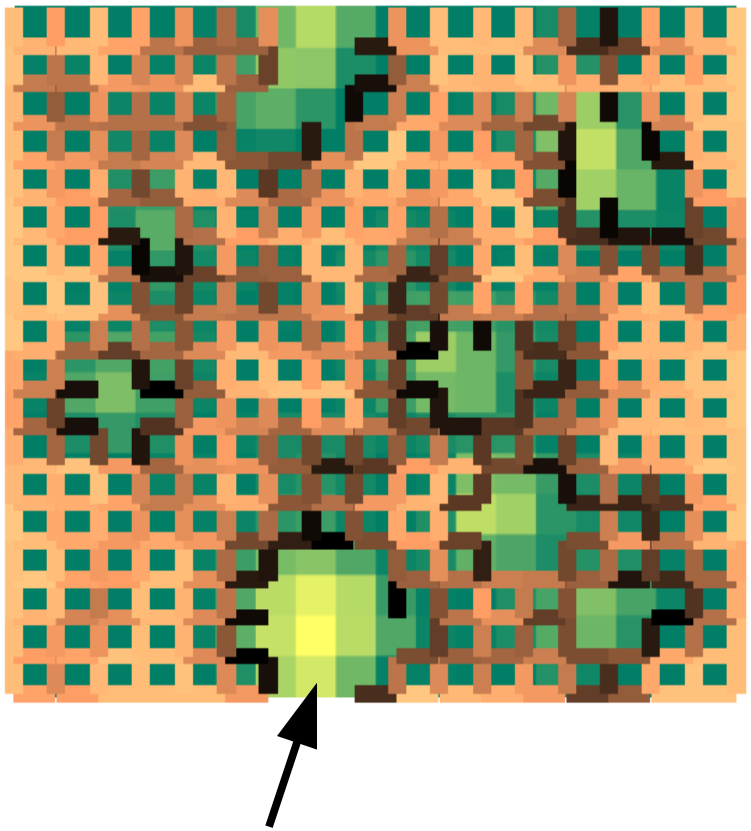




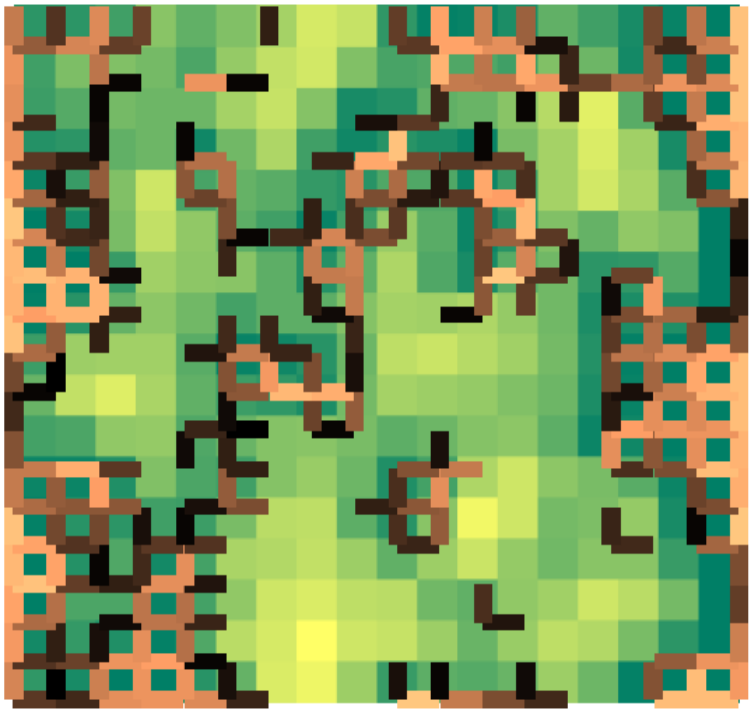

This effect is called the
Kosterlitz-Thouless (KT) transition

It it sometimes useful to think of disordered systems in a percolation picture.

Low T

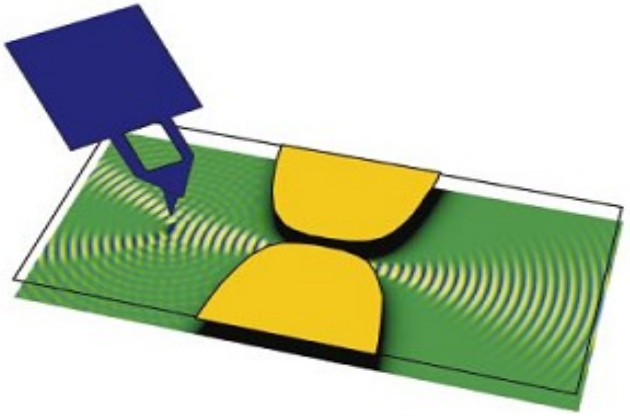


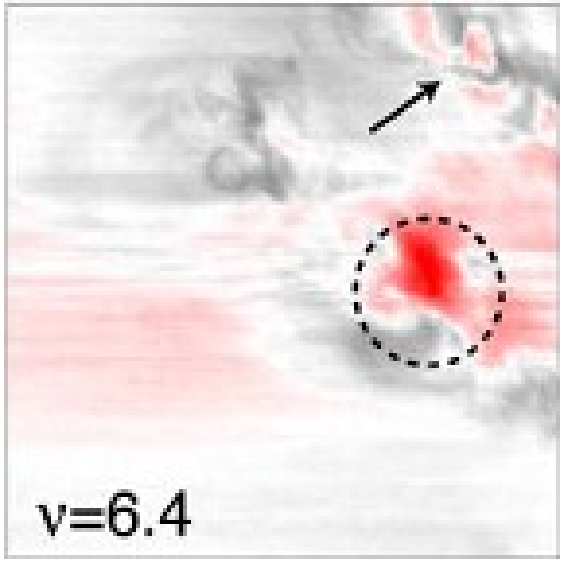
High T



Trapped vortex-antivortex pairs

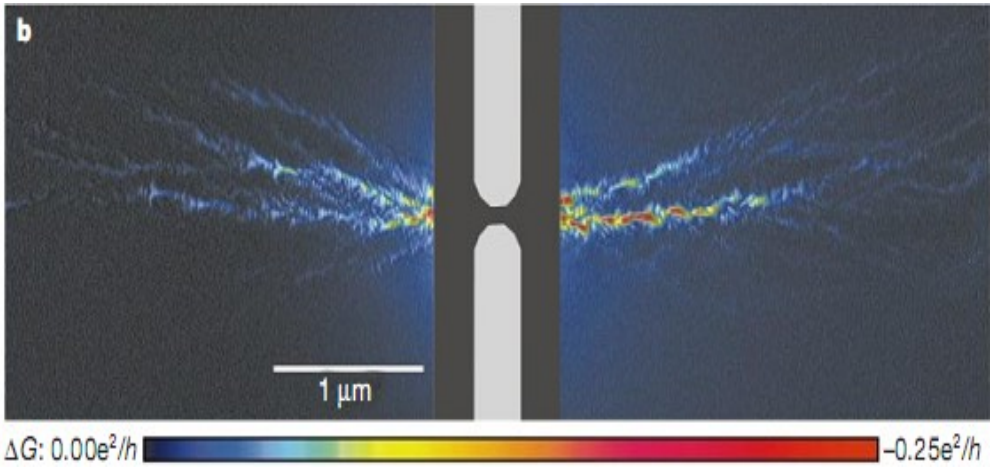
Our next step:
We suggest an experiment to probe the percolating cluster:





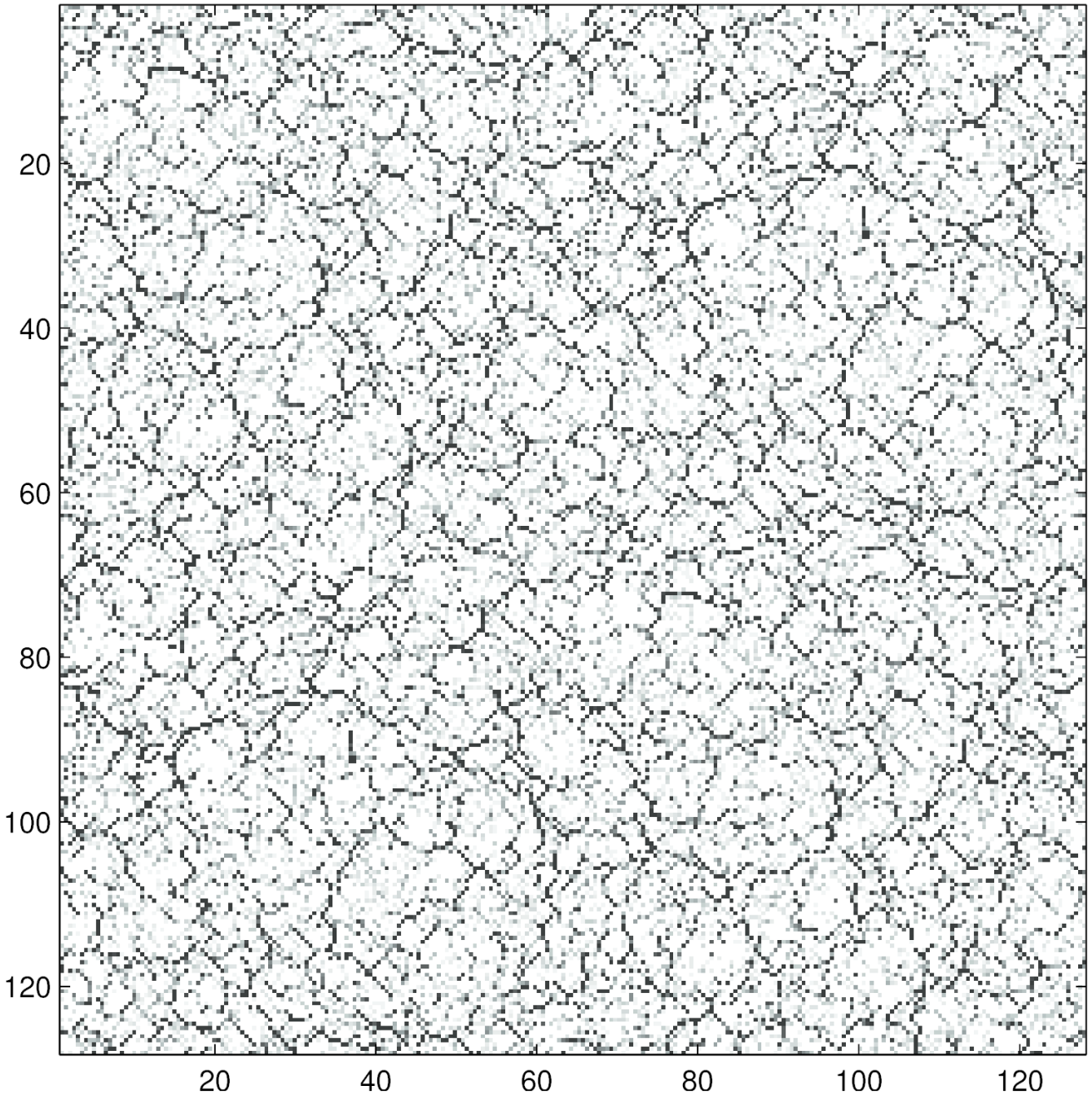
Ensslin et al.

PRB 70, 2004

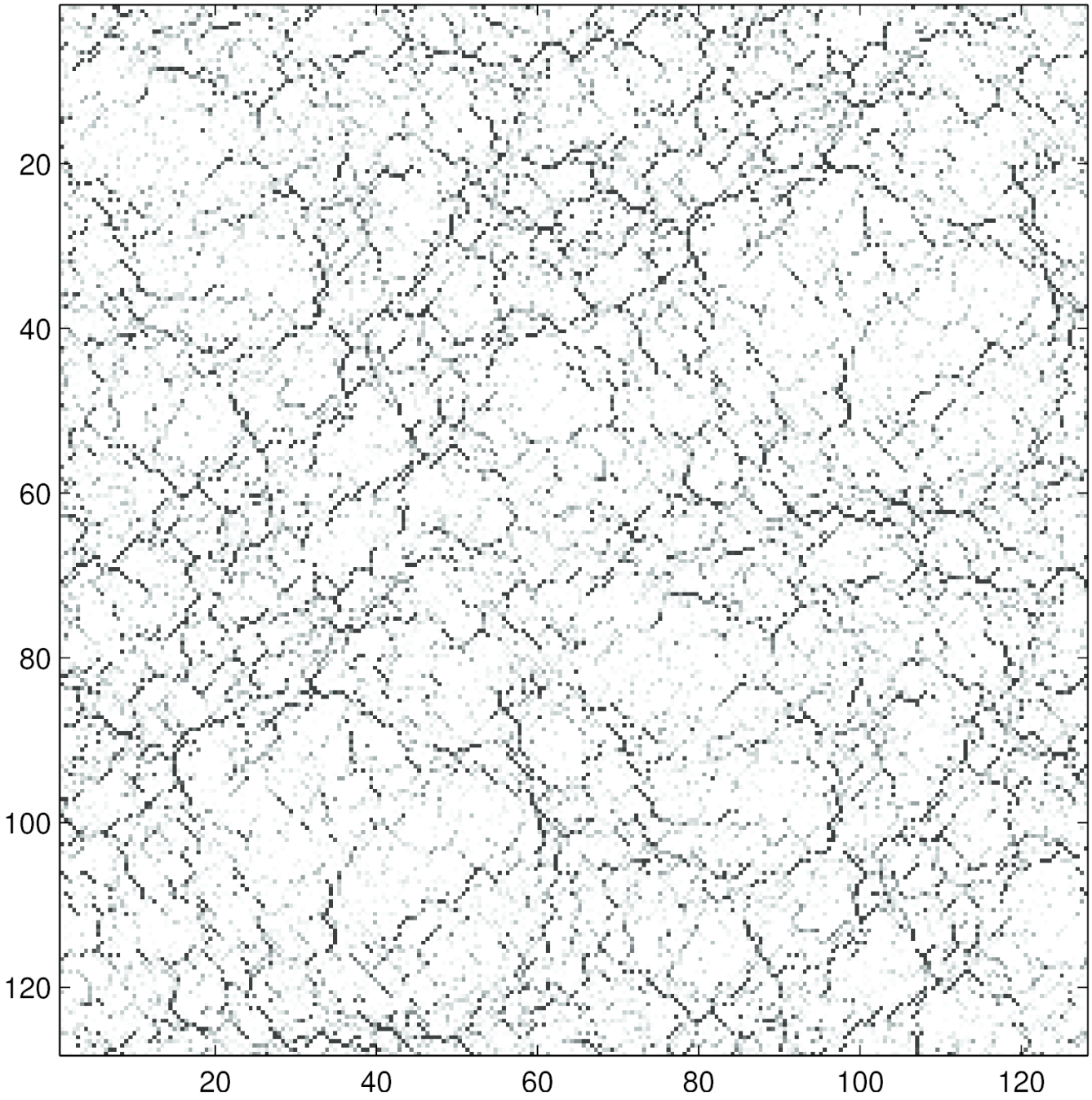


Topinka et al.

Nature 410, 2001



Low
T



Near Tc

Concluding remarks:

· We investigate the effect of disorder on the loss of superconductivity in two-dimensional systems.

· We suggest an experiment to probe the structure of SC correlations.

· Such understanding could pave the way to improved SCs with potentially significant technological advantages.

Thank you for your time