Percolation in Engineering

One of the earliest laboratory investigations of percolation was recording the resistance between opposite sides of a conducting sheet as electrical connections were randomly removed.[1] Most of the experiments involved cutting a small number of wires in a periodic mesh, or cutting round or elliptical holes in a conducting sheet.[2] We have a Universal Laser System 100 watt CO$_2$ laser with a 0.001 inch spot size that can rapidly make large numbers of variable shaped holes anywhere on an 18 inch x 30 inch platform. As shown in the following figure the laser can be programmed to make random cuts in a conducting sheet like aluminized mylar between electrodes 1 & 2, while simultaneously making sequential cuts between electrodes 2 & 3, so that the sheet's resistance vs. remaining area can be recorded (Figure 2). This approach can increase the number of cuts carried out in the laboratory experiment (100,000 or more) as well as change the hole shape from those well studied numerically (i.e. circles) to those which can not be studied as well numerically (i.e., asterisk cut).

Figure 2. Left - Orange electrodes 1 & 2 monitor resistance across green square as ~1200 elliptical cuts in red are made in a conducting sheet. The largest remaining cluster is indicated in cyan. Right – As the red elliptical cuts reduce the area remaining in the left green square, cuts are made to reduce height of conducting path between orange electrodes 2 & 3. In this figure 39.2% of the sheet's area remained when the last conducting path between electrodes 1 & 2 was removed.

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