

APPENDIX C

How the Challenges are Solved

To circumvent the problem of vibrations, the STM is usually operated in constant-current mode, which makes use of a feedback controller. The feedback controller measures the actual tunneling current and compares it to a desired value that the operator can control. The tip is connected to a positioner that is in turn connected to the feedback controller. Voltages from the feedback controller change the length of the positioner. The tip will be pulled away from the surface if the current is higher than desired or lowered toward the surface if the current value is lower than desired. In this way the desired current value is maintained as the probe scans over the surface. The change in the positioner's length is directly proportional to the applied voltage. Thus, changes in voltage produced by the feedback controller are directly proportional to the changes in surface height.

At each location on the surface, the computer measures the surface height based on the voltage applied to maintain constant tunneling current. This two-dimensional array of numbers, representing heights at different positions in the area surveyed, is often represented by gray-scale imaging. With gray-scale imaging, the height at each point is represented by the intensity of color with white used for showing the highest points and black for the lowest points. As a result, the image created shows a striking resemblance to the atomic model. The deep holes correspond to the positions of missing atoms in the model. The bright spots correspond to the atoms that protrude above the surface plane. The STM does not actually give the physical positions of the atoms, but it senses their electrons and bonds. As a result, the current detected is dependent upon both the tip-to-atom distance as well as the chemical identity of the surface atoms.