ATOMIC FORCE MICROSCOPE MODEL

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Abstract

Since only a small fraction of High School students will have physics related careers one must ask what the general student population will get out of a physics class. Scientific literacy and a knowledge of the nature of science is missing in our nation's citizenry. And with our society becoming more technology based this knowledge is something that has never been more important. We have constructed a simple model of an Atomic Force Microscope that will fit into any high school teacher's budget. The model keeps the electronics to a minimum while providing a great tool for teaching students the nature of science. While many laboratory activities and inquiry assignments are decontectualized and must be tied to science through analogies and metaphors, this model will enable students to discover the nature of science by using an apparatus similar to those actually used in research science.

Mechanical Set Up

The mechanical set up of the model is similar to an AFM but much simpler and scaled up about 10,000 times. The weight of the cantilever is what keeps the tip in contact with the sample. A laser is bounced off the cantilever and up to a photodetector which is easily constructed with two phototransistors set against each other. As the sample is moved under the tip the position of the beam on the detector is centered more or less on one of the phototransistors. Peaks on the surface of the sample will register as positive voltages while valleys register negative. Plotting voltage vs. time gives us an image of the surface of the sample.

The model used Texas Instraments CBL System to collect and display data

Contextualized Activities

Many of the inquiry activities and lessons that are currently used to teach the nature of science are decontextualized or removed from actual science and must be tied to it through analogies. These techniques do a good job of teaching the methodologies used in scientific reasoning, but the ways they actually tie to scientific literacy might get lost in their interpretation by some students.

Using the AFM model will allow students to participate in contextualized activities that are directly tied to research science. The added confusion of using analogies to teach the nature of science are avoided. Students will be able to learn, " The distinguishing characteristics that set science apart from other ways of knowing and from other bodies of knowledge through the use of emperical standards, logical arguments, and skepticism." (NRC 1996)

Typical set of samples students would use to scan.

Activities

Activities with this model will help students learn how to read and interpret data, decide what information they can consider reasonably reliable taking into account the limitations of the technology, and recognize the difference between and observation and an inference.

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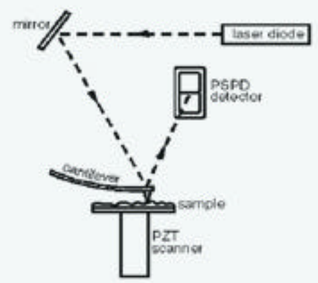
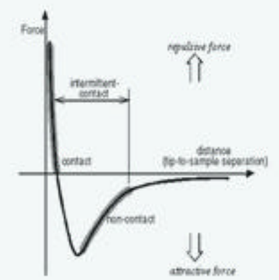
The Real Deal

"In contact-AFM mode, also known as repulsive mode, an AFM tip makes soft 'physical contact' with the sample. The tip is attached to the end of a cantilever with a low spring constant, lower than the effective spring constant holding the atoms of the sample together. As the scanner gently traces the tip across the sample (or the sample under the tip), the contact force causes the cantilever to bend to accommodate changes in topography." (http://thermomicro.com/)



The beam-bounce detection scheme.



Interatomic force vs. distance curve.