



NEAR-FIELD THERMAL RADIATIVE TRANSFER BETWEEN SPHERICAL OBJECTS

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The aim of the project...

- ❖ is to investigate near-field thermal radiative heat transfer between closely spaced spherical objects.
- ❖ is to propose scaling laws for near-field thermal radiation heat transfer between two microspheres using an experimental apparatus.

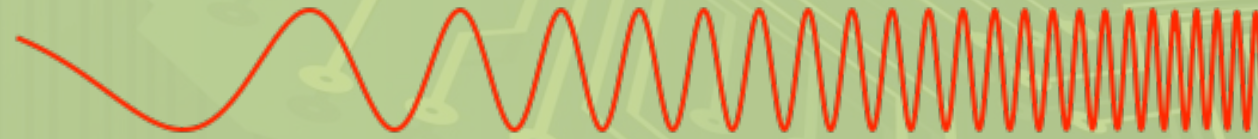
Background Information

❖ What is Thermal Radiation?

It is the light emitted by hot objects. As the temperature of the object increases, it emits most of its light at higher and higher energies and higher energy light means shorter wavelength light.

Wavelength Spectrum

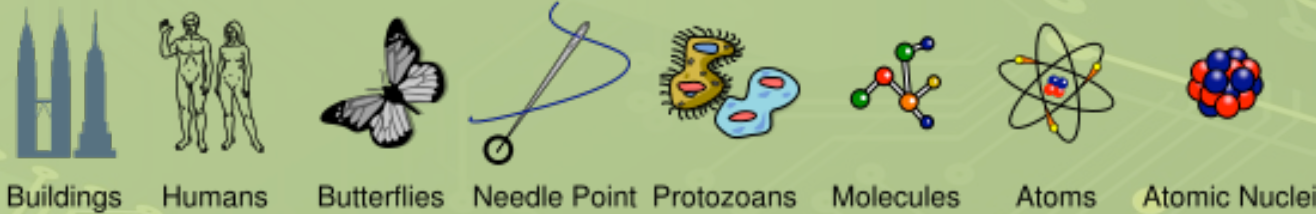
Penetrates Earth's Atmosphere?



Radiation Type
Wavelength (m)

Radiation Type	Wavelength (m)
Radio	10^3
Microwave	10^{-2}
Infrared	10^{-5}
Visible	0.5×10^{-6}
Ultraviolet	10^{-8}
X-ray	10^{-10}
Gamma ray	10^{-12}

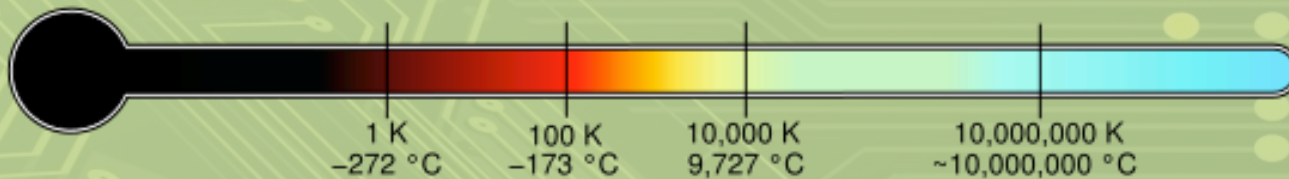
Approximate Scale of Wavelength



Frequency (Hz)



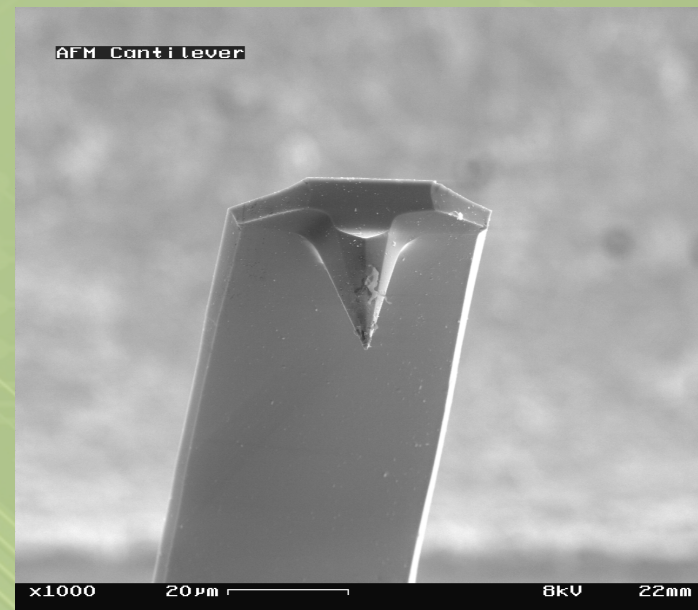
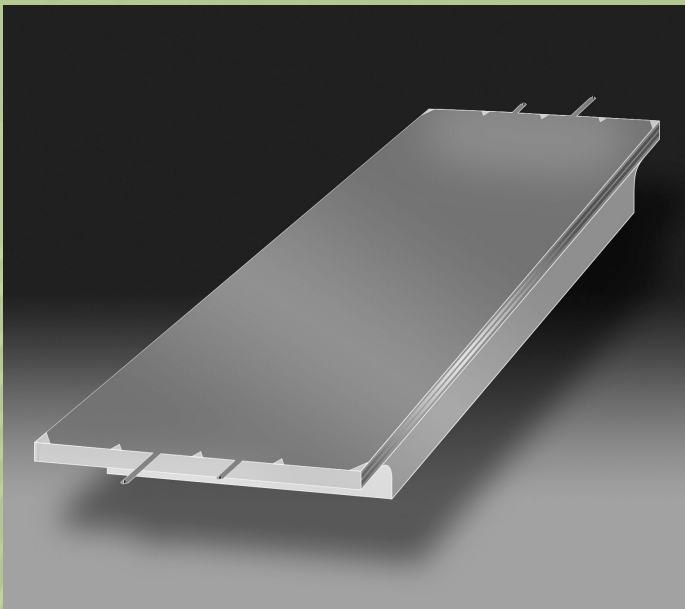
Temperature of objects at which this radiation is the most intense wavelength emitted

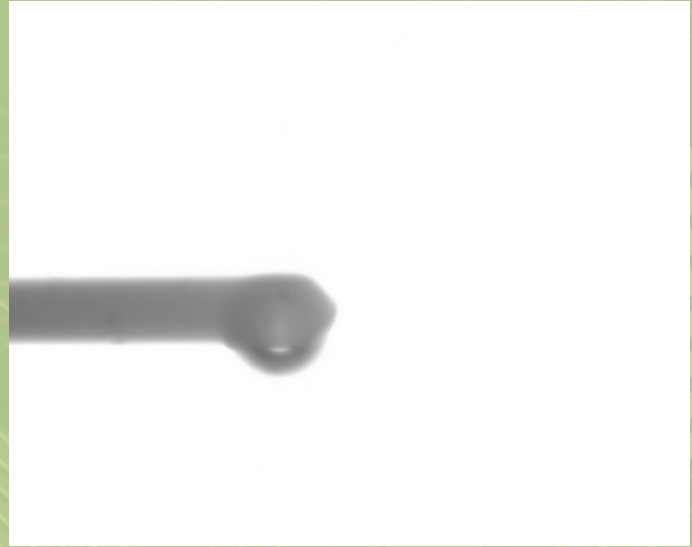
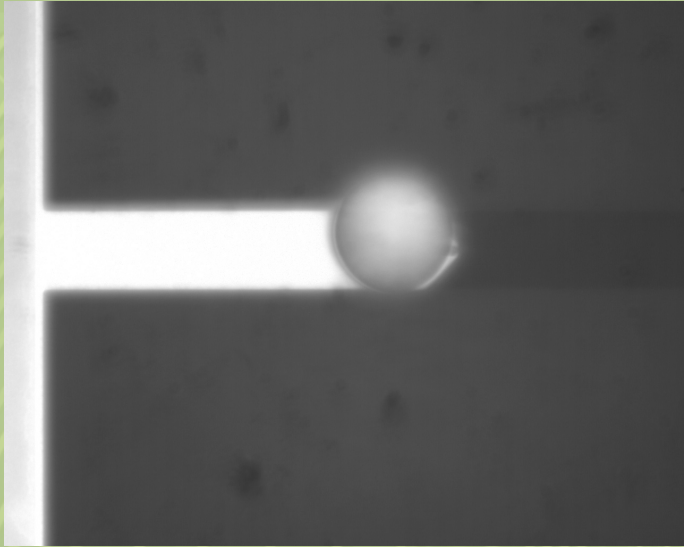
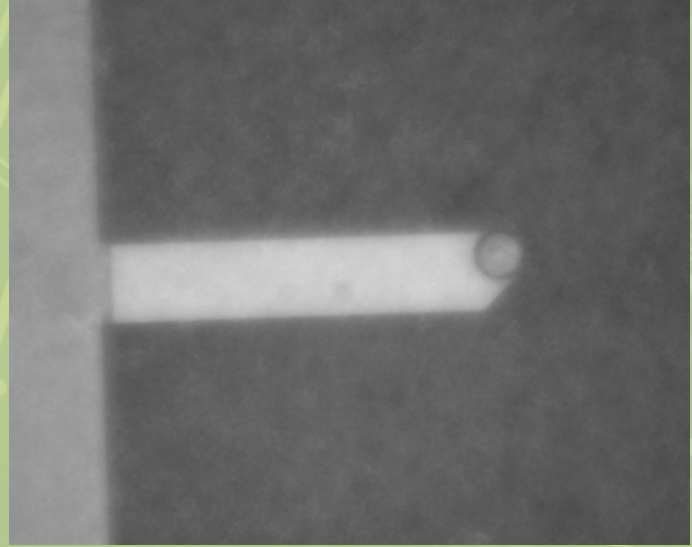
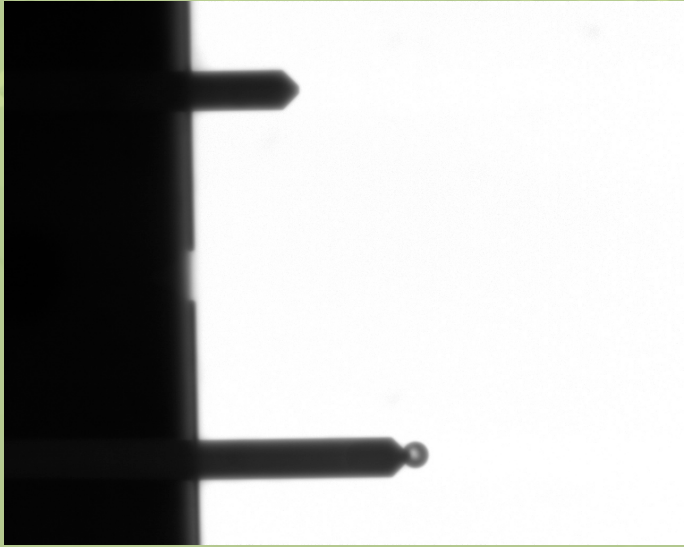


Cantilever

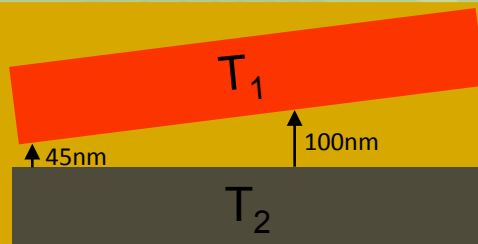
❖ What is Cantilever?

The cantilever is a very sensitive force measurement device.

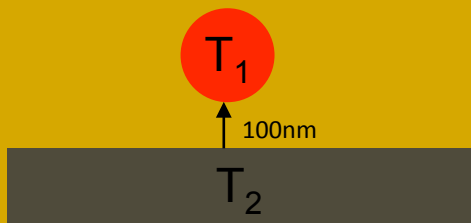




Reasons to use spherical objects



- Parallel plate configuration
 - ↑ Reasonable to analyze
 - ↓ Experimentally very challenging



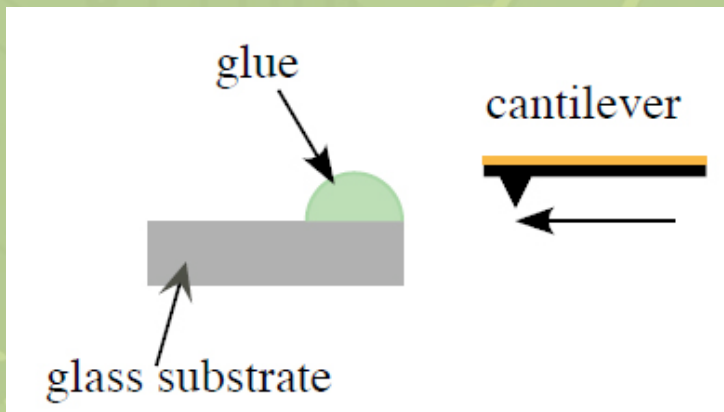
- Sphere-plate configuration
 - ↓ Hardest to analyze
 - ↑ Experimentally easier

Materials

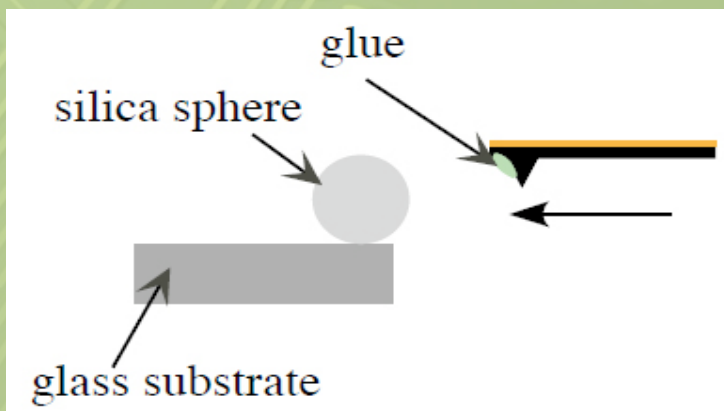
- ❖ Laser diode module
- ❖ A lens system to focus the laser beam
- ❖ The AFM cantilever and its holder
- ❖ A substrate
- ❖ And a position sensing detector (PSD)

Why do we use AFM cantilever?

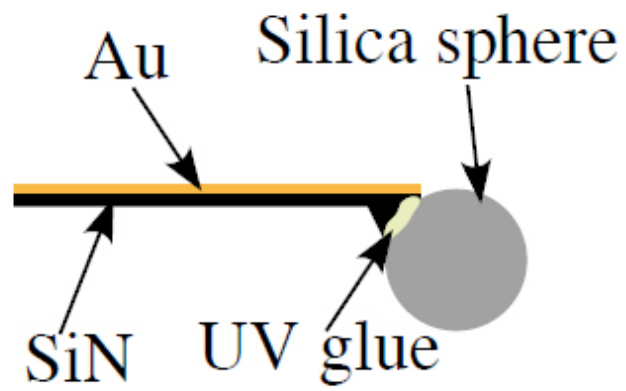
- ❖ Because it is very sensitive and in our experiment and we will use it in order to understand the radiative heat transfer at nano-scale.



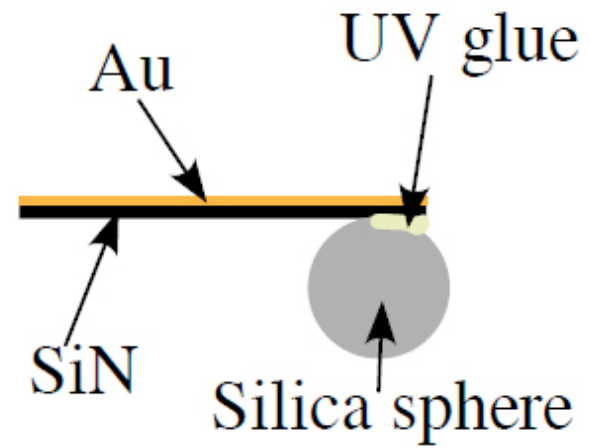
A drop of glue is deposited at the edge of a glass substrate. The cantilever position is adjusted using a micro-manipulator so that the tip just touches the glue. All this is done under a microscope (100X magnification).



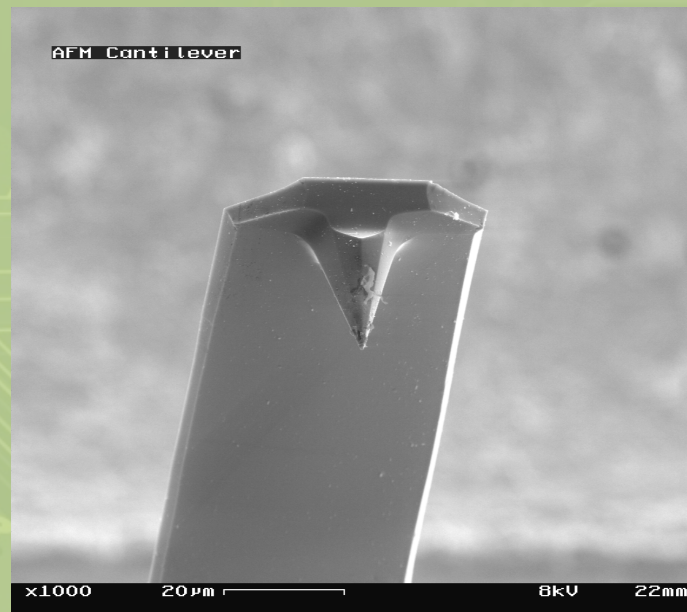
A microsphere is adjusted so that it is right at the edge of a clean glass substrate. The sphere adheres to the glue near the tip.



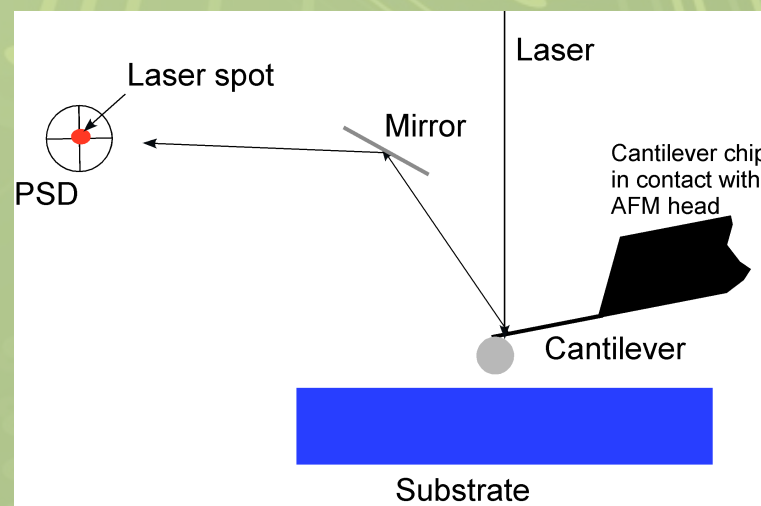
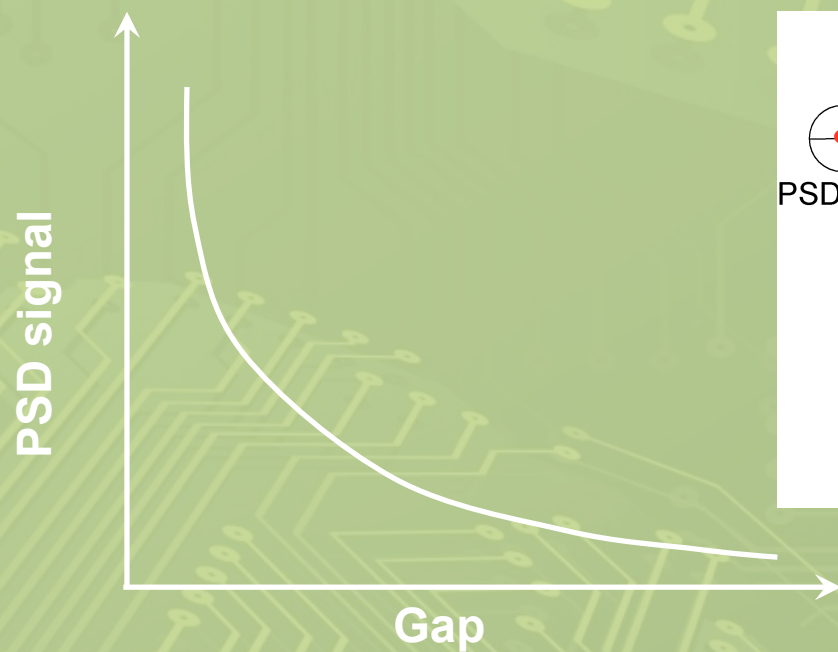
(a) Good attachment.



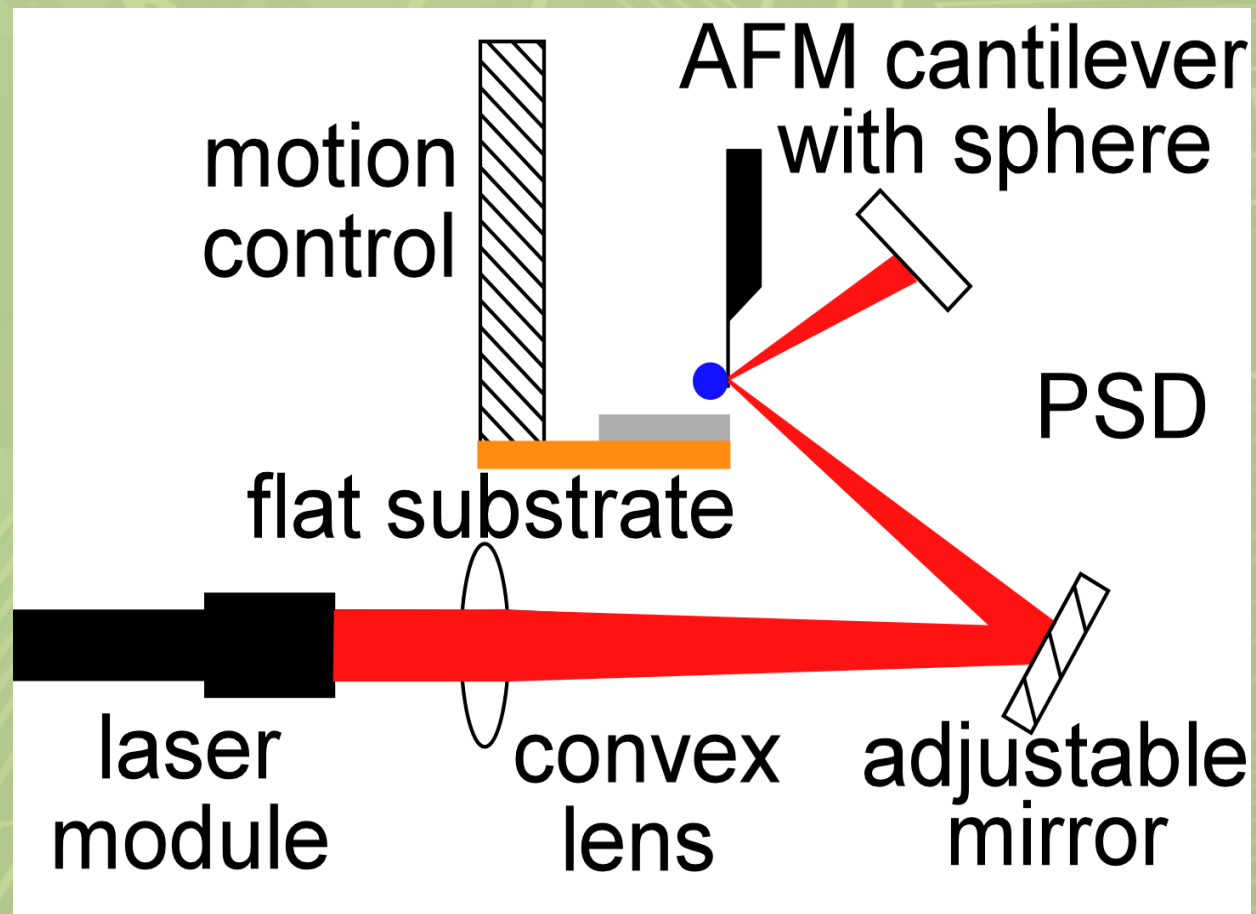
(b) Bad attachment.



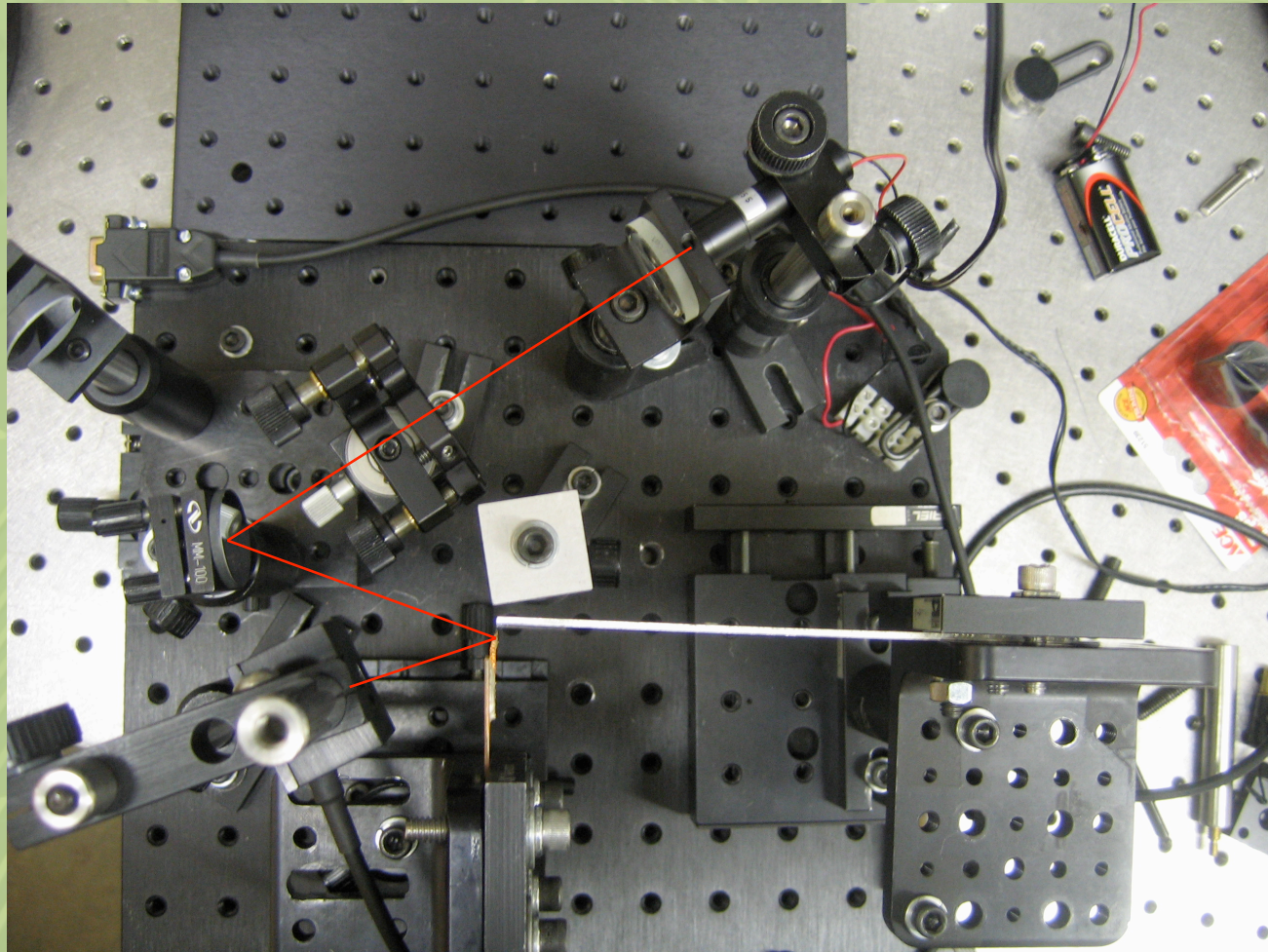
AFM-based near-field experiment



Schematic of experimental apparatus



Experimental Setup



Results

- ❖ We've completed the number of the cantilevers that are attached to sphere.
- ❖ Future Work
 - Measure near-field radiative transfer between substrate and sphere which we attached to cantilevers.

References

- ❖ <http://www.egglescliffe.org.uk/physics/astronomy/blackbody/bbody.html>
- ❖ <http://web.mit.edu/newsoffice/2009/heat-0729.html>
- ❖ <http://cass.ucsd.edu/public/tutorial/Planck.html>
- ❖ <http://www.wikipedia.com>
- ❖ Arvind Naranayaswamy's Thesis about Investigation of Nano-scale Thermal Radiation

Acknowledgments

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QUESTIONS?

