WHAT IS CLAIMED IS:

1. A method for resonance-enhanced detection using a scanning probe microscope comprising:

driving a cantilever with a probe tip of the scanning probe microscope to vibrate;

modulating a light source in a range of frequencies to irradiate an interface between the probe tip and a sample with modulated electromagnetic radiation from the light source;

detecting a vibrational response of the cantilever in response to the modulated electromagnetic radiation at the interface between the probe tip and the sample; and

measuring amplitude of the vibrational response of the cantilever over the range of modulation frequencies to derive a photo-induced force microscope (PiFM) value representing a sum of the vibrational response of the cantilever at all frequencies over the range of modulation frequencies, wherein

(i) the modulating the light source includes applying a frequency-swept modulation signal to the light source so that frequency of the modulated electromagnetic radiation sweeps the range of frequencies, and wherein the measuring the amplitude of the vibrational response of the cantilever over the range of modulation frequencies includes integrating the amplitude of the vibrational response of the cantilever over the range of modulation frequencies to derive the PiFM value or

(ii) the modulating the light source comprises applying a modulation signal to the light source so the modulated electromagnetic radiation simultaneously has the range of modulation frequencies, and the measuring the amplitude comprises simultaneously measuring the amplitude of the vibrational response of the cantilever in response to the modulated electromagnetic radiation to derive the PiFM value.

2. The method of claim 1, wherein the modulating the light source comprises applying the frequency-swept modulation signal to the light source, and wherein the vibrational response of the cantilever includes responses to forces or force gradients excited by the modulated electromagnetic radiation at the interface between the probe tip and the sample.

3. The method of claim 2, wherein measuring the amplitude of the vibrational response of the cantilever includes mixing a modulation frequency of the light source and a cantilever

dither frequency to derive a sum or difference frequency that is used to detect the forces or force gradients.

4. The method of claim 3, wherein measuring the amplitude of the vibrational response of the cantilever includes using the sum or difference frequency as a reference for a lock-in detector.

5. The method of claim 1, wherein the modulating the light source comprising applying the modulation signal to the light source, and wherein the modulation signal comprises a modulation waveform signal that includes a sum or difference of multiple frequency components within the range of frequencies.

6. The method of claim 5, wherein the modulation waveform signal is generated by reverse Fourier transform of a spectral density of the range of frequencies to be applied.

7. The method of claim 1, wherein the modulating the light source comprises applying the modulation signal to the light source, and wherein measuring the amplitude of the vibrational response of the cantilever includes measuring the amplitude using a bandpass filter and an amplitude detector.

8. A scanning probe microscope comprising:

a cantilever with a probe tip;

a dither drive unit connected to the cantilever to drive the cantilever to vibrate;

a light source to irradiate an interface between the probe tip and a sample;

a signal generator connected to the light source to modulate the light source in a range of frequencies to irradiate an interface between the probe tip and the sample with modulated electromagnetic radiation from the light source,

a detector to detect a vibrational response of the cantilever in response to the modulated electromagnetic radiation at the interface between the probe tip and the sample; and

an amplitude measuring system to measure amplitude of the vibrational response of the cantilever over the range of modulation frequencies to derive a photo-induced force

microscope (PiFM) value representing a sum of the vibrational response of the cantilever at all frequencies over the range of modulation frequencies, wherein:

(i) the signal generator is configured to apply a frequency-swept modulation signal to the light source so that frequency of the modulated electromagnetic radiation sweeps the range of frequencies, and wherein the amplitude measuring system is configured to integrate the amplitude of the vibrational response of the cantilever over the range of modulation frequencies to derive the PiFM value; or

(ii) the signal generator is configured to apply a modulation signal to the light source so the modulated electromagnetic radiation simultaneously has the range of frequencies, and the amplitude measuring system includes an amplitude detector to simultaneously measure the amplitude of the vibrational response of the cantilever in response to the modulated electromagnetic radiation to derive the PiFM value.

9. The scanning probe microscope of claim 8, wherein the signal generator is configured to apply the frequency-swept modulation signal to the light source, and wherein the vibrational response of the cantilever includes responses to forces or force gradients excited by the modulated electromagnetic radiation at the interface between the probe tip and the sample.

10. The scanning probe microscope of claim 9, wherein the amplitude measuring system includes a mixer to mix a modulation frequency of the light source and a cantilever dither frequency to derive a sum or difference frequency that is used to detect the forces or force gradients.

11. The scanning probe microscope of claim 10, wherein the amplitude measuring system includes a lock-in detector connected to the detector to receive the detected vibrational response of the cantilever, the lock-in detector being also connected to the mixer to receive the sum or difference frequency that is used as a reference for lock-in detection.

12. The scanning probe microscope of claim 8, wherein the signal generator is configured to apply the modulation signal to the light source, and wherein the signal generator is configured to generate a modulation waveform signal that includes a sum or difference of multiple frequency components within the range of frequencies.

13. The scanning probe microscope of claim 12, wherein the signal generator is configured to generate the modulation waveform by reverse Fourier transform of a spectral density of the range of frequencies to be applied.

14. The scanning probe microscope of claim 8, wherein the signal generator is configured to apply the modulation signal to the light source, and wherein the amplitude measuring system includes a bandpass filter and an amplitude detector to measure the amplitude of the vibrational response of the cantilever.

15. The scanning probe microscope of any of claims 8 to 14, wherein the light source is a tunable infrared (IR) laser.