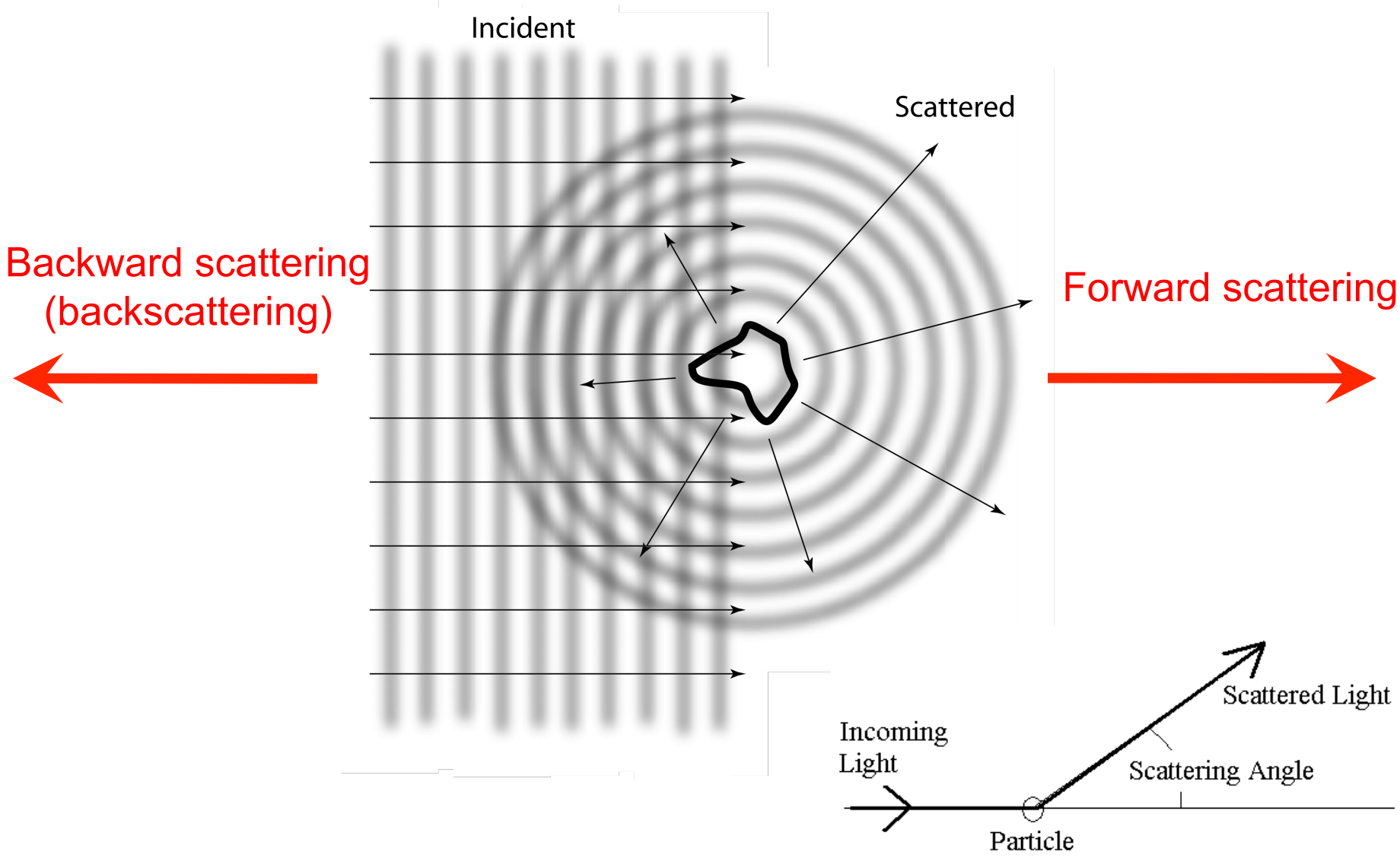
Scattering

Scattering fundamentals

- Scattering can be broadly defined as the *redirection of radiation out of the original direction of propagation*, usually due to interactions with molecules and particles
- Reflection, refraction, diffraction etc. are actually all just forms of scattering
- Matter is composed of discrete electrical charges (atoms and molecules – dipoles)
- Light is an oscillating EM field – excites charges, which radiate EM waves
- These radiated EM waves are *scattered waves*, excited by a source external to the scatterer
- The *superposition of incident and scattered EM waves* is what is observed

Scattering geometry



Types of scattering

- Elastic scattering – the wavelength (frequency) of the scattered light is the same as the incident light (*Rayleigh and Mie scattering*)

- Inelastic scattering – the emitted radiation has a wavelength different from that of the incident radiation (*Raman scattering, fluorescence*)

- Quasi-elastic scattering – the wavelength (frequency) of the scattered light shifts (e.g., in moving matter due to Doppler effects)

Parameters governing scattering

- (1) The wavelength (λ) of the incident radiation

- (2) The size of the scattering particle, usually expressed as the non-dimensional size parameter, x:

$$x = \frac{2\pi r}{\lambda}$$

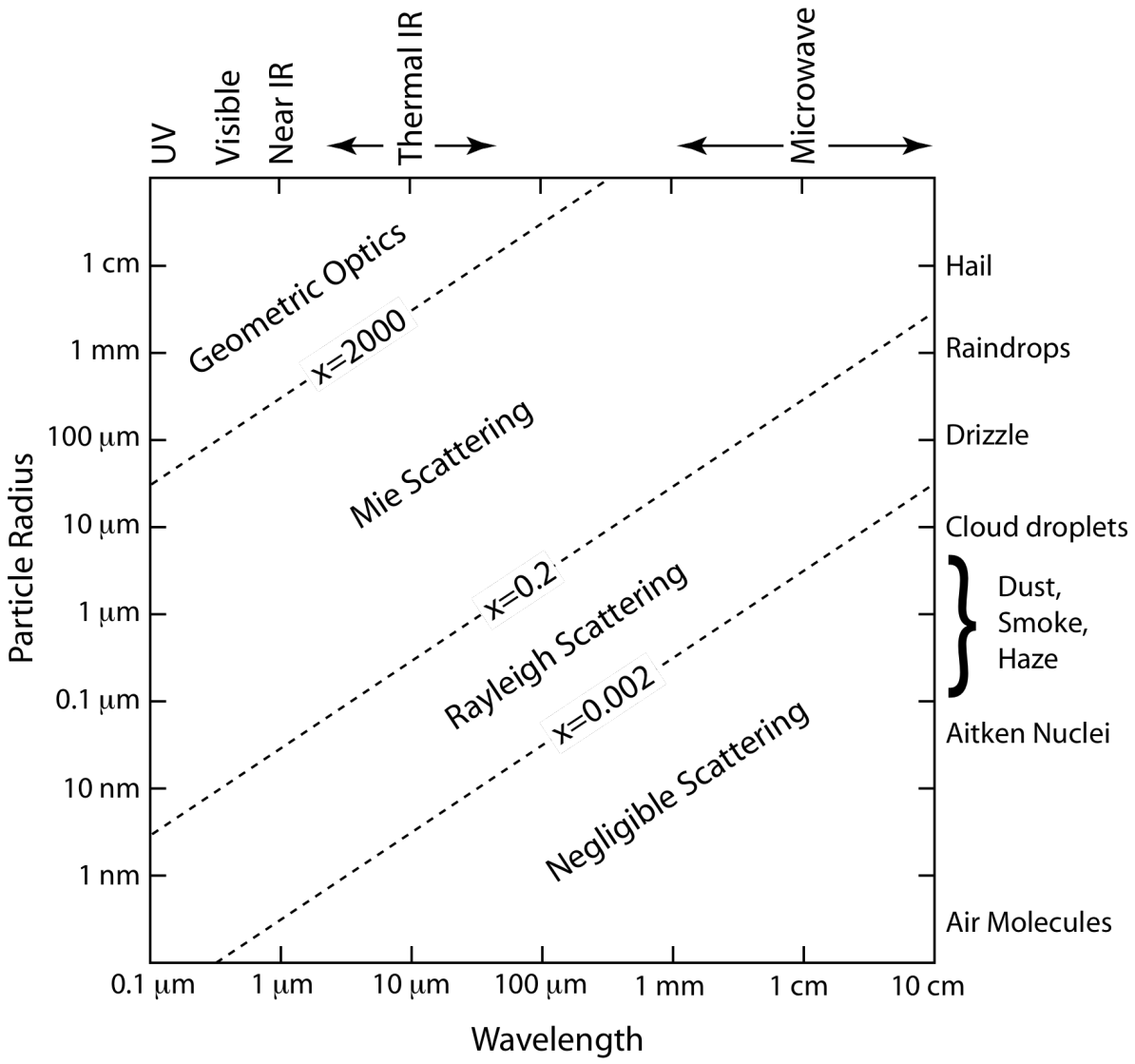
- **r** is the radius of a spherical particle, **λ** is wavelength

- (3) The particle optical properties relative to the surrounding medium: the complex refractive index

- Scattering regimes:

  - **x << 1** : Rayleigh scattering
  - **x ~ 1** : Mie scattering
  - **x >>1** : Geometric scattering

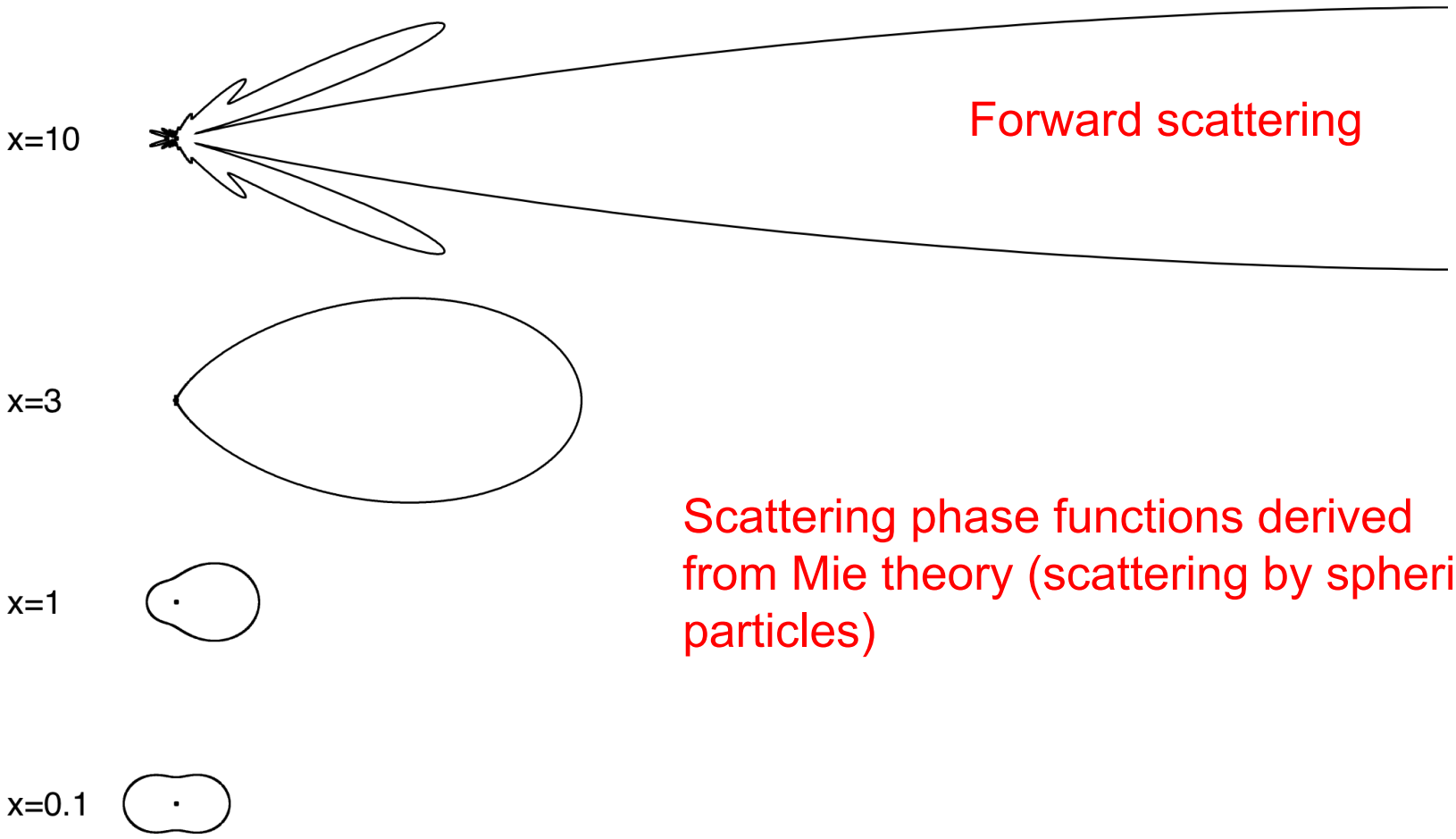
Light scattering regimes



There are many regimes of particle scattering, depending on the particle size, the light wave-length, and the refractive index.

This plot considers only single scattering by spheres. Multiple scattering and scattering by non-spherical objects can get really complex!

Scattering phase functions



Scattering phase functions derived from Mie theory (scattering by spherical particles)

The scattering phase function, or phase function, gives the angular distribution of light intensity scattered by a particle at a given wavelength