# Atmospheric Physics

Lecture 1

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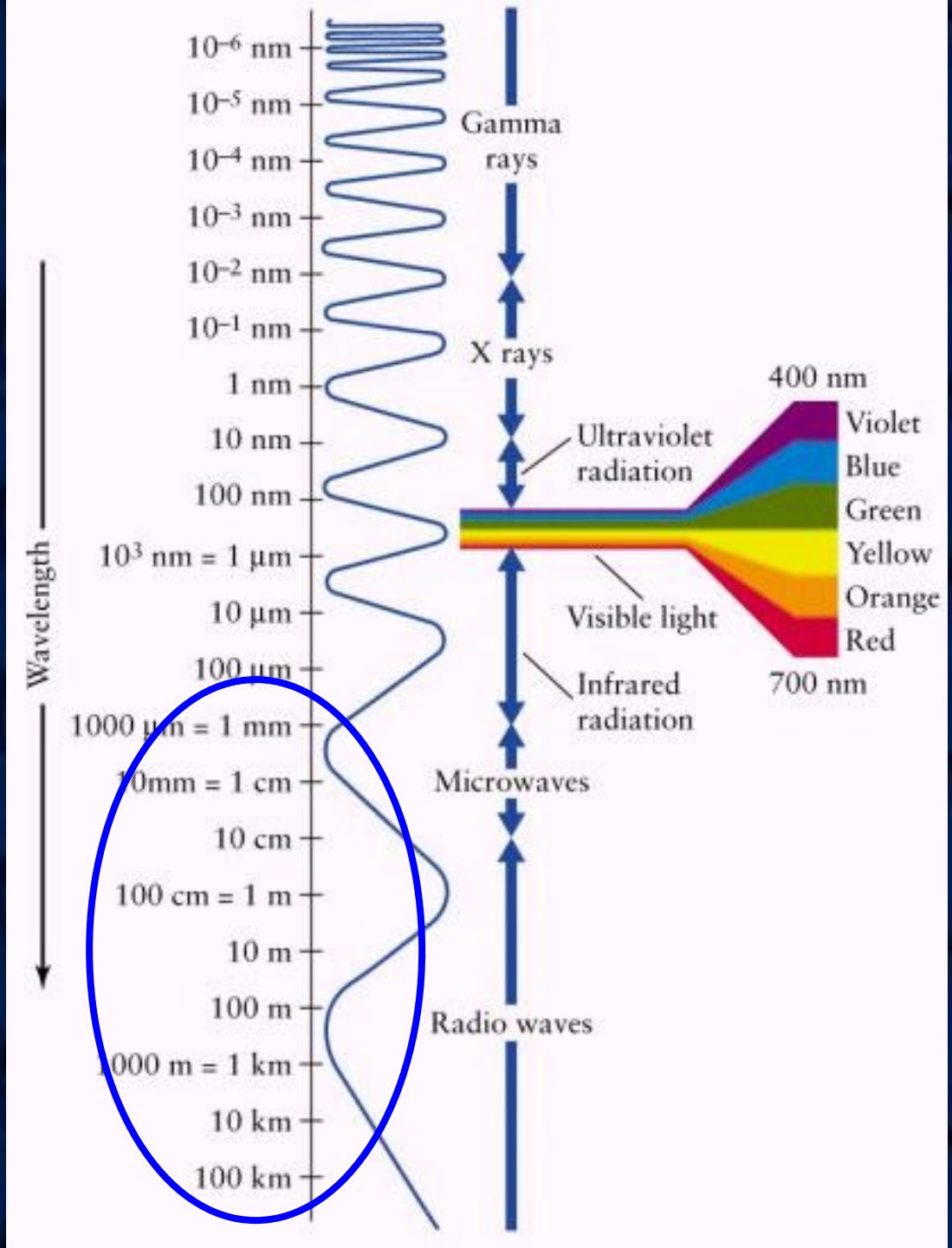
# Atmospheric radiation

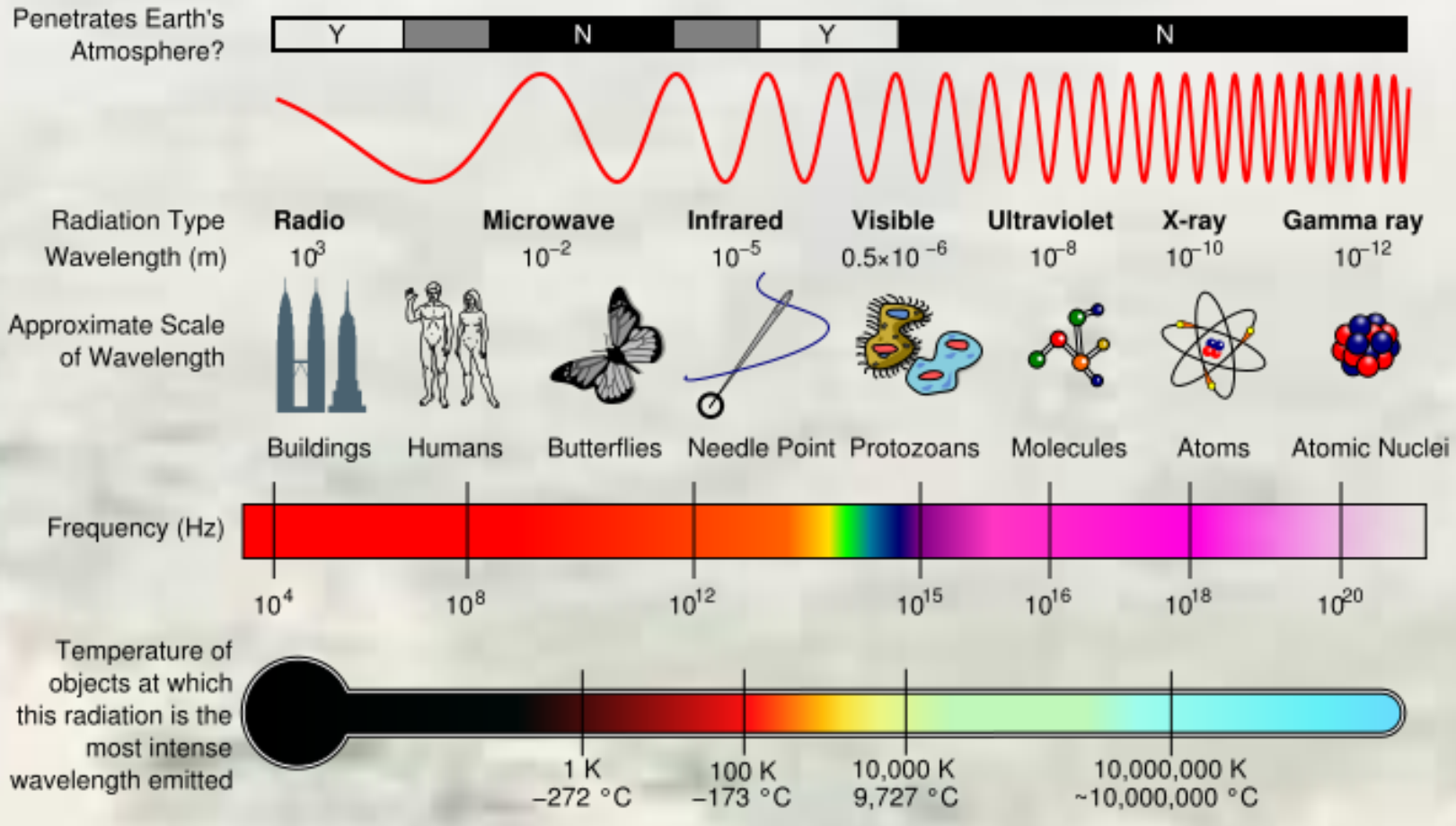
## Basic physical concepts

The subject of atmospheric radiation is concerned with the transfer of energy within the atmosphere by photons, or equivalently by electromagnetic waves.

# The Electromagnetic Spectrum



# Light (visible radiation)
# Heat (thermal or infrared radiation)



The subject of atmospheric radiation is concerned with the transfer of energy within the atmosphere by photons, or equivalently by electromagnetic waves.

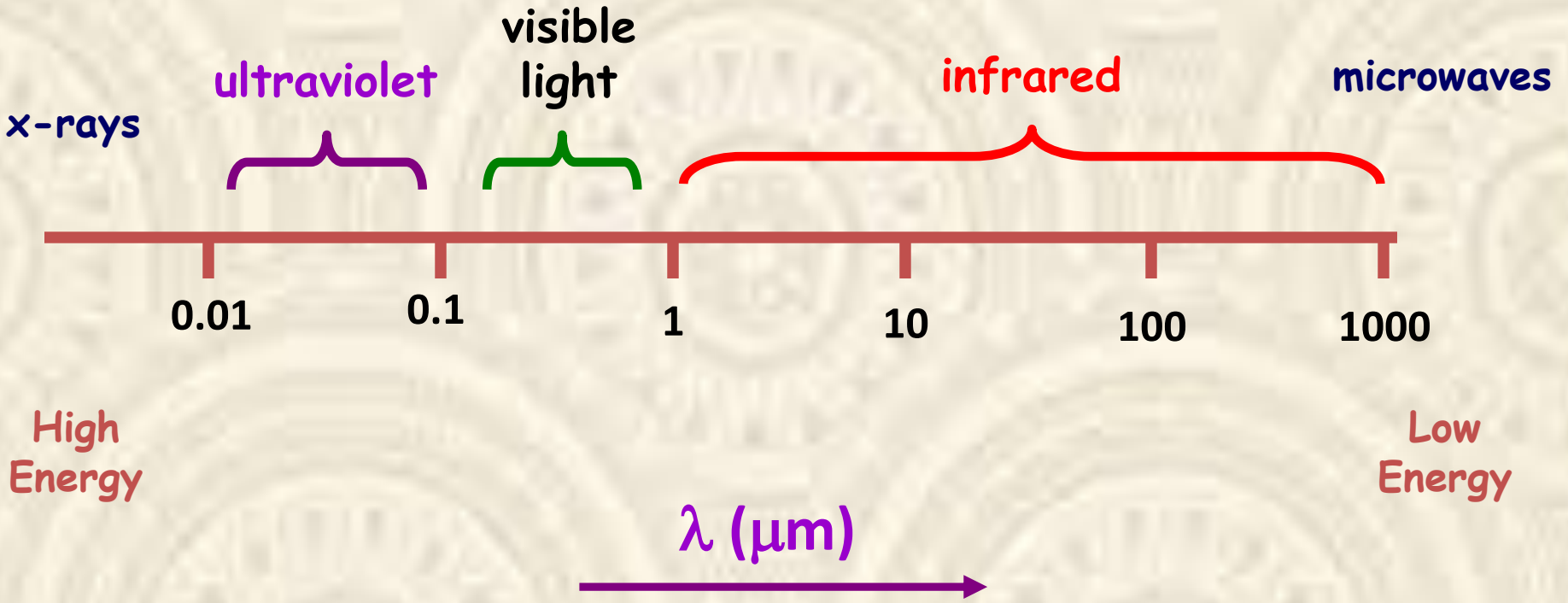
We recall that the wavelength of visible light lies between the violet at about 0.4 μm (400 nm) and the red at about 0.7 μm (700 nm).

Ultra-violet radiation has wavelengths shorter than 400 nm

and infra-red radiation has wavelengths longer than 0.7 μm.

It is convenient to split the infrared into the near infra-red, between about 0.7 and 4 μm, the thermal infra-red, between about 4 and 50 μm, and the far infra-red, between about 50 μm and 1mm.

# Electromagnetic Spectrum



In the atmosphere, the relevant photons fall naturally into two classes.

Solar (or short-wave) photons, emitted by the Sun;

these correspond to ultra-violet, visible and near infra-red wavelengths between about 0.1 and 4 μm.

Thermal(or long-wave) photons,

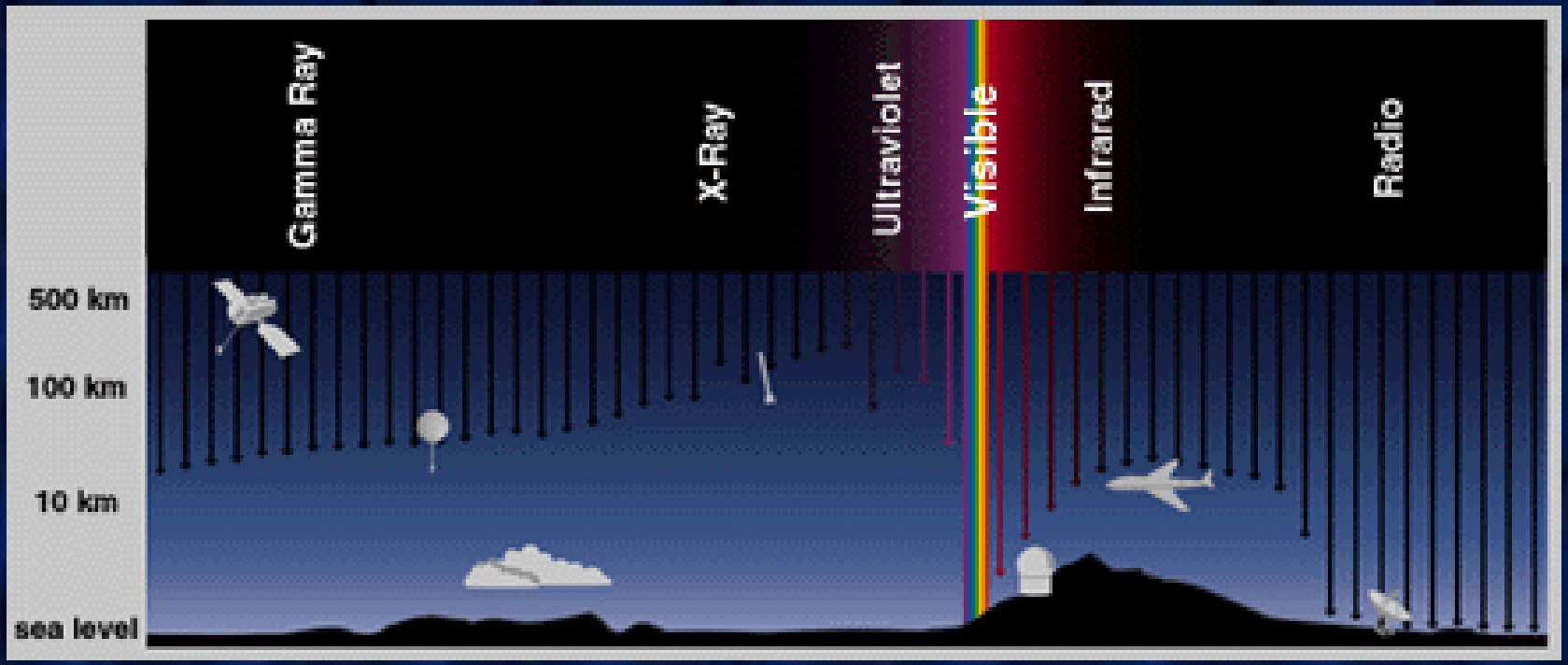
emitted by the atmosphere or the Earth's surface; these correspond mainly to thermal infra-red and far infra-red wavelengths, between about 4 and 100 μm.

These two wavelength ranges represent spectral regions of significant black-body emission at temperatures of

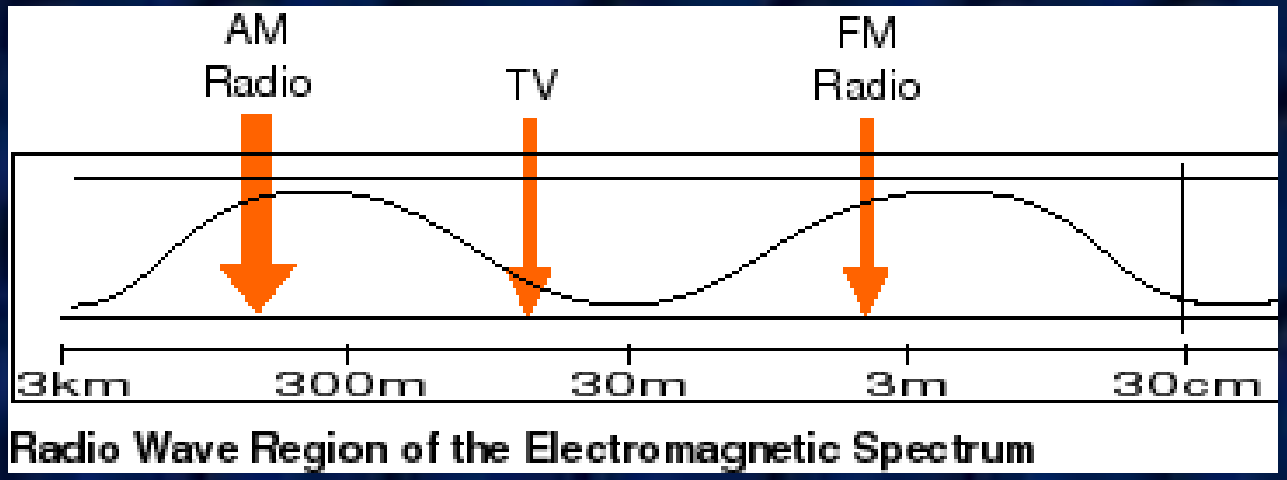
about 6000K (a temperature representative of the solar photosphere)

And

288K (the Earth's mean surface temperature), respectively;



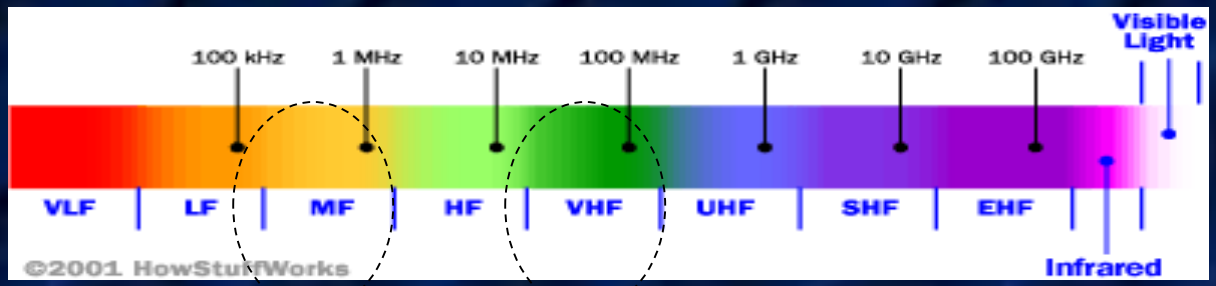

# Radio Waves




Radio Wave Region of the Electromagnetic Spectrum

# Radio waves of our interest

| | | |
|---|---|---|
| VLF | 3 - 30 | kHz |
| LF | 30 - 300 | kHz |
| MF | 300 - 3000 | kHz |
| HF | 3 - 30 | MHz |
| VHF | 30 - 300 | MHz |
| UHF | 300 - 3000 | MHz |




AM radio FM radio/TV

For example, an AM radio system transmits electromagnetic waves with frequencies of 535 KHZ to 1.7 MHZ (MF band)

The FM radio system must operate with frequencies in the range of 88-108 MHz (VHF band)

Radio waves have the longest wavelengths in the electromagnetic spectrum.

These waves can be longer than a football field or as short as a football.

Radio waves do more than just bring music to your radio.

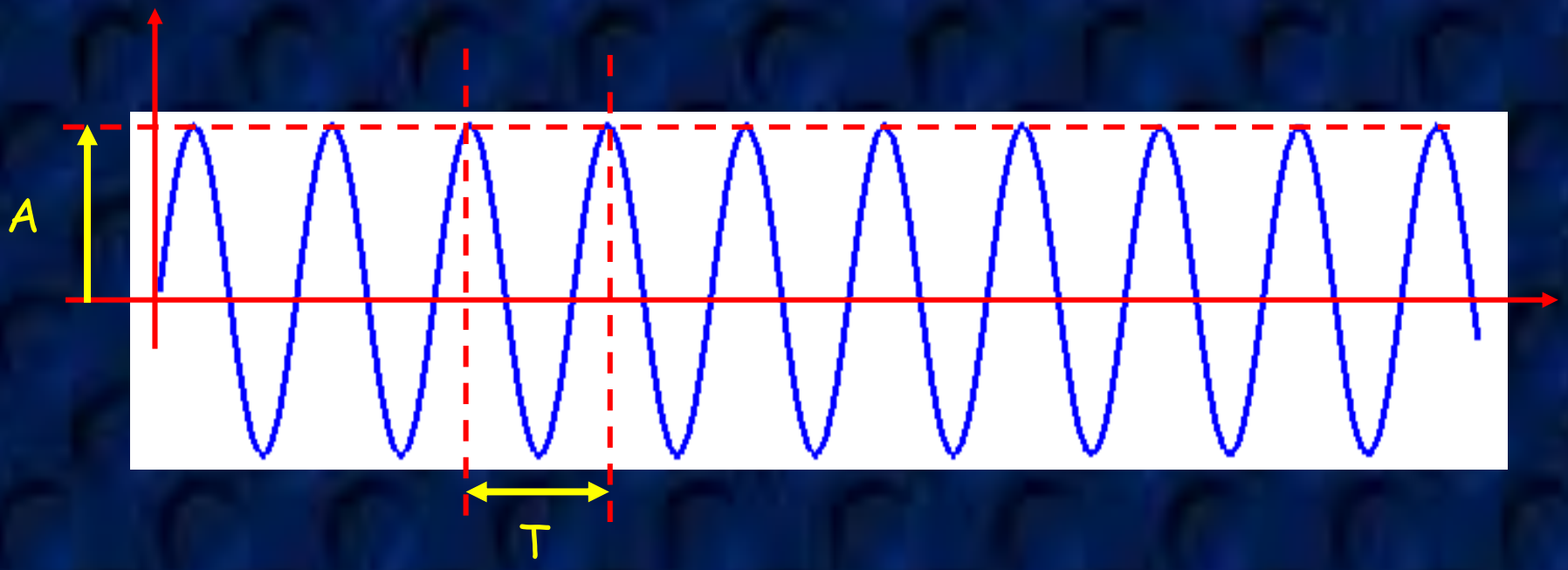
They also carry signals for your television and cellular phones.

Cellular phones also use radio waves to transmit information.

These waves are much smaller than TV and FM radio waves.

Why are antennae on cell phones smaller than antennae on your radio?

# Transmitting information




a signal like the one above does not transmit any information

it just goes up and down, up and down both the amplitude (A) and the period (T) or frequency f = 1 / T never change

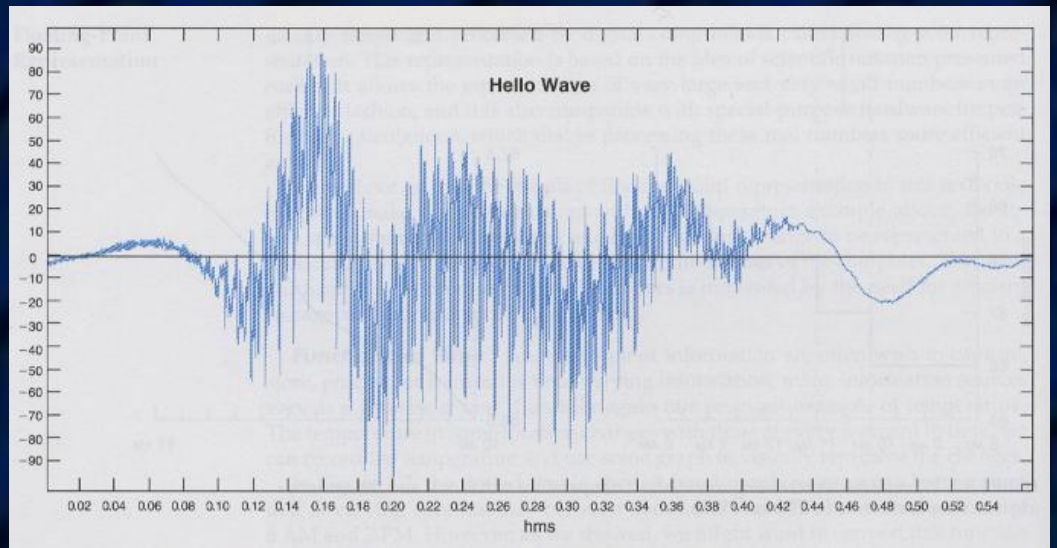
# Analog Modulation

The purpose of a communication system is to transmit information signals (baseband signals) through a communication channel

The term *baseband* is used to designate the band of frequencies representing the original signal as delivered by the input transducer

For example, the voice signal from a microphone is a baseband signal, and contains frequencies in the range of 0-3000 Hz

The "hello" wave is a baseband signal:

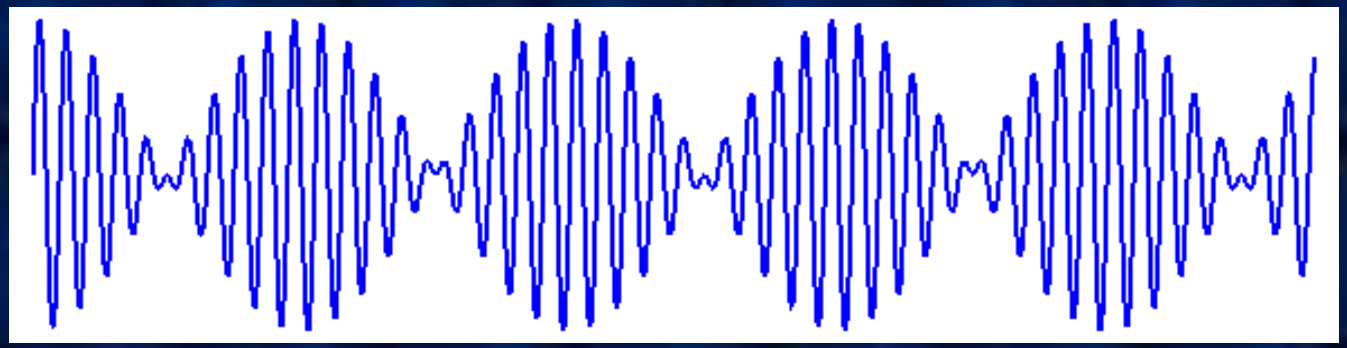


# Amplitude Modulation (AM)

with AM the amplitude of the wave signal (carrier) is modulated (changed).

Amplitude modulation is the process of varying the amplitude of a carrier wave in proportion to the amplitude of a baseband signal.

the information is coded into the way that the amplitude is modulated



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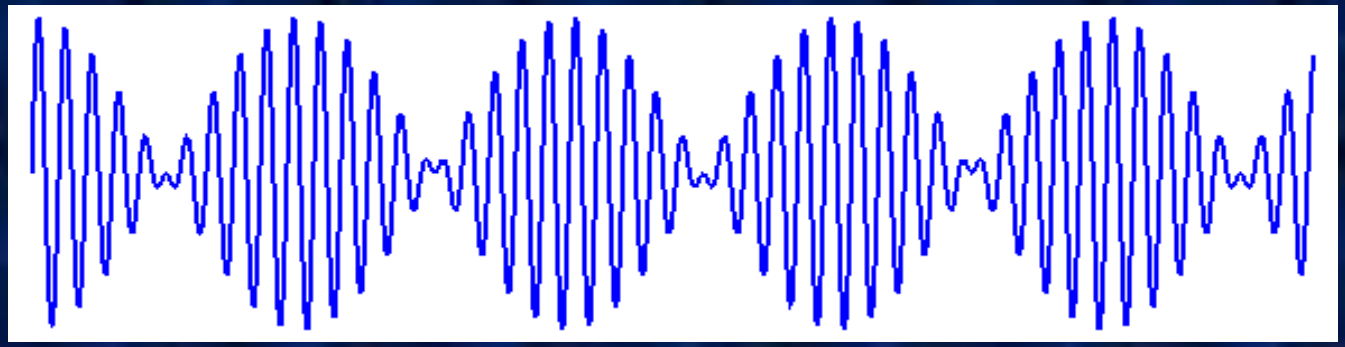
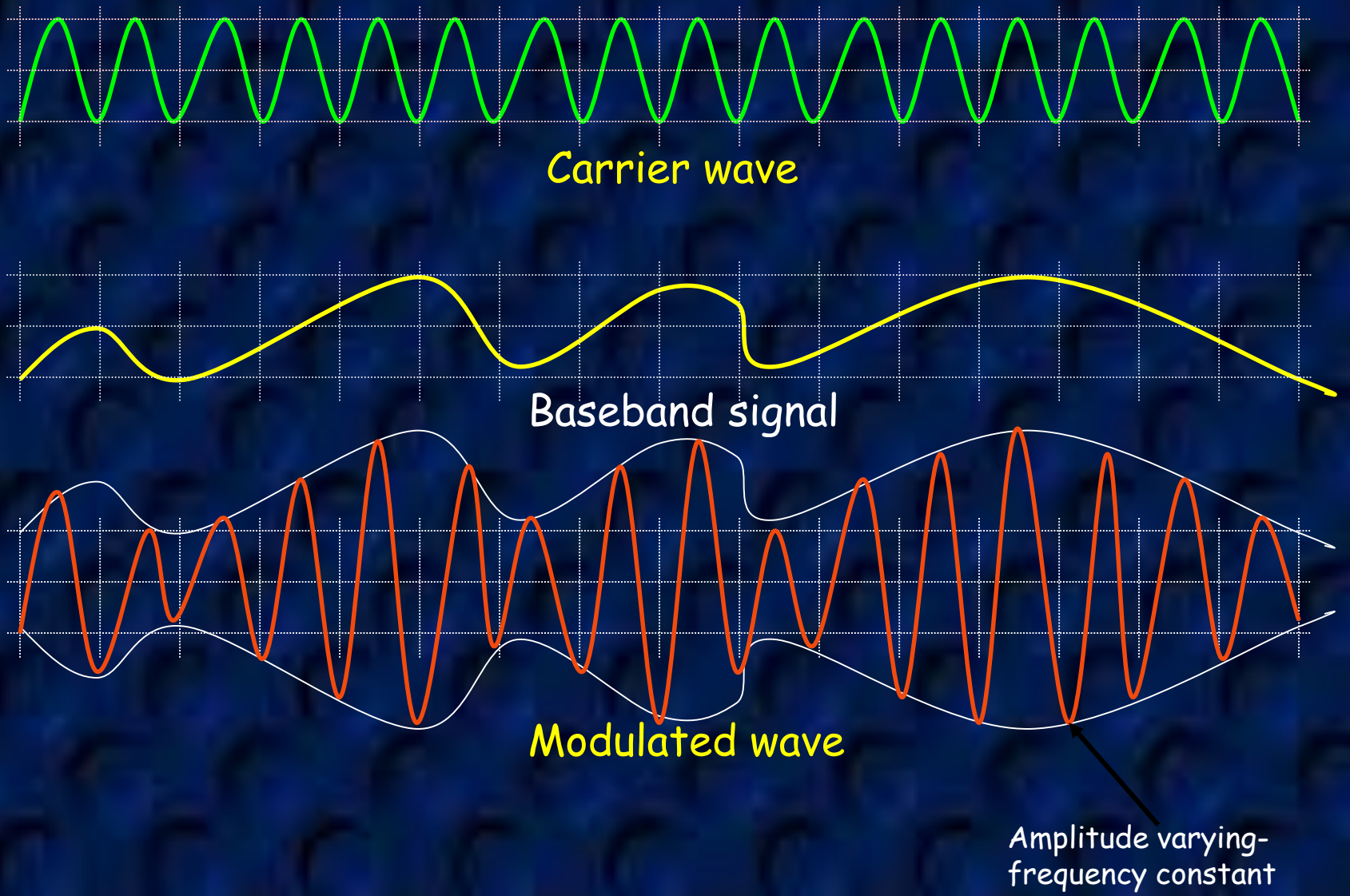


# Amplitude Modulation

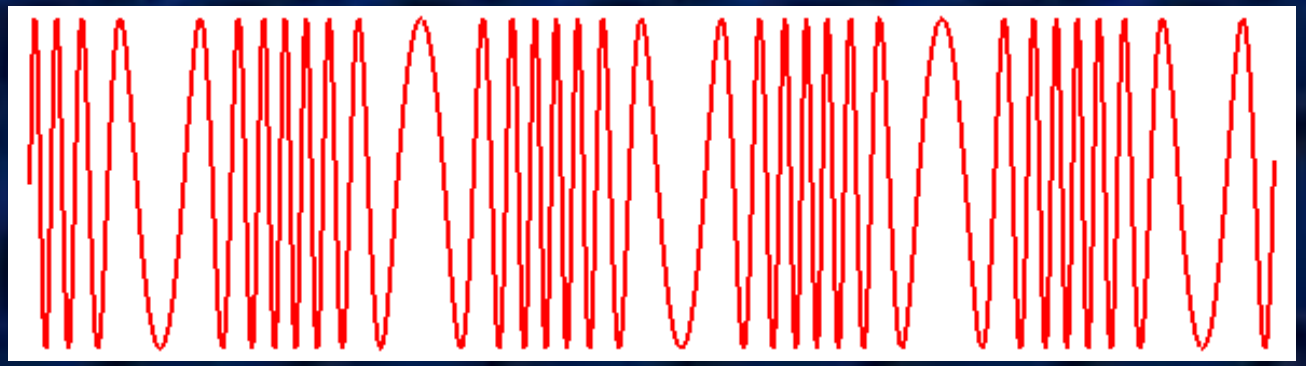


# Frequency modulation (FM)

with FM signals the frequency of the signal is modulated

Frequency modulation is the process of varying the frequency of a carrier wave in proportion to the amplitude of a baseband signal

information is coded into the way that the modulation frequency is varied



# Frequency Modulation