Q: distance waves can travel based on frequency (Answered ★★★★★, 3 Comments)

Question

Subject: **distance waves can travel based on frequency**
Category: Science > Physics
Asked by: **simrangambhir-ga**
List Price: $10.00

Posted: 10 Oct 2006 06:58 PDT
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Hi,

Will a wave with a higher frequency (or higher amplitude) travel further?

eg. As you go away from a radio base station that might be emitting radio waves at differenct frequencies, which ones are likely to be clearly till further away and why?

Answer

Subject: **Re: distance waves can travel based on frequency**
Answered By: **sublime1-ga** on 10 Oct 2006 15:20 PDT
Rated: ★★★★★

simrangambhir...

I was an electronics technician in the US Navy.

First, frequency is independent of amplitude. Frequency has to do with the distance between sequential crests of a sine wave. The greater the distance, the lower the frequency. Amplitude has to do with the heighth of the waveform.

See this Google search for images and sites on sine waves:
://www.google.com/search?q=sine+wave

Amplitude has to do with the signal strength, which has an effect on distance in that, the stronger the signal, the further it can travel.

Given two signals of equal strength and different frequencies, lower frequencies travel further than higher ones. AM radio signals, in the range of 520 to 1,710 KHz, can often be picked up at distances of 100-300 miles, while FM frequencies of 88 MHz to 108 MHz are limited to what's known as line-of-sight transmission, topping out at around 50-60 miles, at best. Khz = thousands of Hertz, or cycles per second, and Mhz = millions of Hertz (Hz), so the high end of the AM frequency band, 1,710 Khz = 1.71 Mhz, vs the 88-108 Mhz range of the FM band.

Note that AM and FM differ in the type of modulation they use, but this is irrelevant to the distance which the signal can travel based on frequency. The frequency and strength of the transmitted signal, which is called the 'carrier wave', is what determines the distance of propagation. AM and FM differ in that the music or voice content is added to the carrier wave by modulating (varying) the amplitude or the frequency of the transmission wave with the audio signal. AM uses amplitude modulation, and FM uses frequency. The quality of the audio resulting from frequency modulation is much better than that resulting from amplitude modulation, so that AM audio is, by definition, not as clear as FM audio, but this difference is due to the form of modulation, and not the frequency of the carrier.

Given two AM signals of equal strength and different frequencies, the lower frequency will travel further and have greater clarity at equal distances from the respective transmitters. The same would hold two for two FM signals of different frequencies and equal strength.

Also note that higher frequencies tend to form a more

'coherent' signal, like a flashlight vs a lantern, which
make them tend to travel only in a straight line, or
line-of-sight. Lower frequencies travel in what's called
a 'ground wave' during the day, and a 'skywave' at night,
allowing them to travel around the curvature of the earth,
while higher frequencies cannot.

A discussion on the Wikipedia page about AM radio notes:

"Medium wave and short wave radio signals act differently
 during daytime and nighttime. During the day, AM signals
 travel by groundwave, diffracting around the curve of the
 earth over a distance up to a few hundred miles (or
 kilometers) from the signal transmitter. However, after
 sunset, changes in the ionosphere cause AM signals to
 travel by skywave, enabling AM radio stations to be heard
 much farther from their point of origin than is normal
 during the day."
http://en.wikipedia.org/wiki/AM_radio

This page from the Great Yarmouth Radio Club notes:

"The ground wave follows the curvature of the Earth and its
 range does not depend upon the height of the antenna. However,
 the range does depend upon the transmitter power and also upon
 the operating frequency. Low frequencies travel further than
 high frequencies. Thus under ideal low noise conditions (noon,
 during winter), it is possible to communicate over distances of
 about 500 nautical miles at 2 MHz by using a 100 W transmitter.
 At 8 MHz, under the same conditions and using the same transmitter
 power, the maximum range is reduced to about 150 nautical miles.

 Note that ground wave propagation is much less efficient over
 land than it is over sea because of the much lower conductivity
 of the ground and other factors. Consequently, ranges over land
 are greatly reduced.

 Ground wave communications vary daily and with the seasons.
 Greatest communication ranges are achieved during the daytime
 in winter because background noise levels are lowest during
 these hours."
http://www.qsl.net/g3yrc/hf%20propagation/hf%20propagation.htm

sublime1-ga

Additional information may be found from further exploration
of the links provided above, as well as those resulting from
the Google searches outlined below.

Searches done, via Google:

"frequencies travel further"
://www.google.com/search?q=%22frequencies+travel+further%22

sine wave
://www.google.com/search?q=sine+wave

am frequency band
://www.google.com/search?q=am+frequency+band

simrangambhir-ga rated this answer:★★★★★ and gave an additional tip of: $10.00

An absolutely brilliant answer - very insightful. Thankyou very much.

Comments

Subject: **Re: distance waves can travel based on frequency**
From: **sublime1-ga** on 10 Oct 2006 18:36 PDT

simrangambhir...

Thanks very much for the 5 stars, the high praise, and the tip!

sublime1-ga

Subject: **Re: distance waves can travel based on frequency**
From: **stanmartin1952-ga** on 10 Oct 2006 21:37 PDT

A 2.4 ghz portable phone travels further than a 900 mhz phone. I don't think one rule applies everywhere.

Subject: **Re: distance waves can travel based on frequency**
From: **sorwin-ga** on 13 Oct 2006 14:52 PDT

I doubt if one rule applies anywhere. A radio wave can be transmitted right across the solar system. Radio waves are received from other galaxies.

So how does this depend upon the frequencies ?
