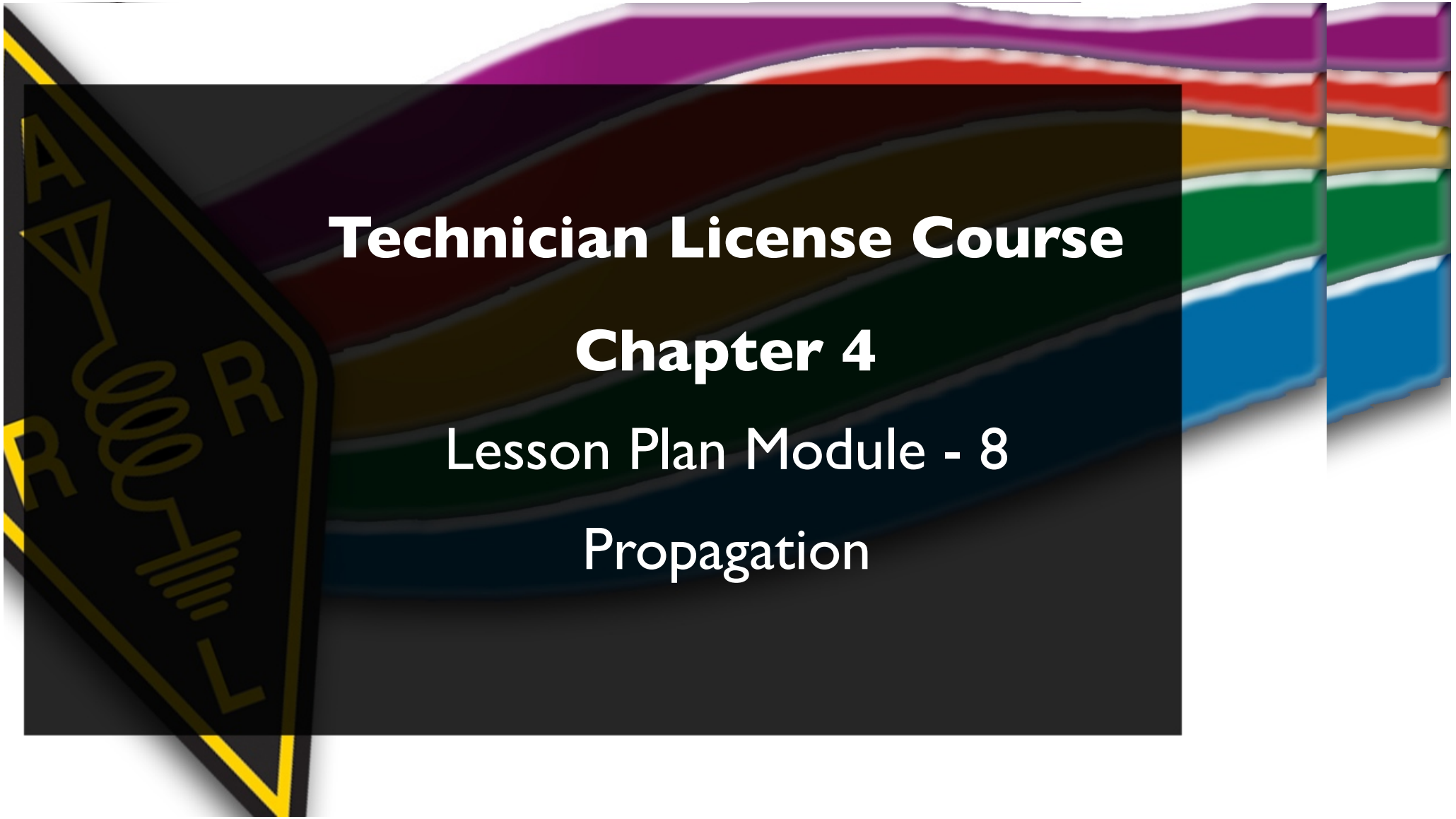
Technician License Course



Technician License Course

Chapter 4

Lesson Plan Module - 8

Propagation

Radio Wave Propagation: Getting from Point A to Point B

- Radio waves *propagate* in many ways depending on…
  - –Frequency of the wave
  - –Characteristics of the environment
- We will discuss three basic ways:
  - –Line of sight
  - –Ground wave
  - –Sky wave

Line-of-Sight

- Radio energy can travel in a straight line from a transmitting antenna to a receiving antenna – called the *direct path*
  - There is some attenuation of the signal as the radio wave travels due to spreading out
- This is the primary propagation mode for VHF and UHF signals.

Ground Wave

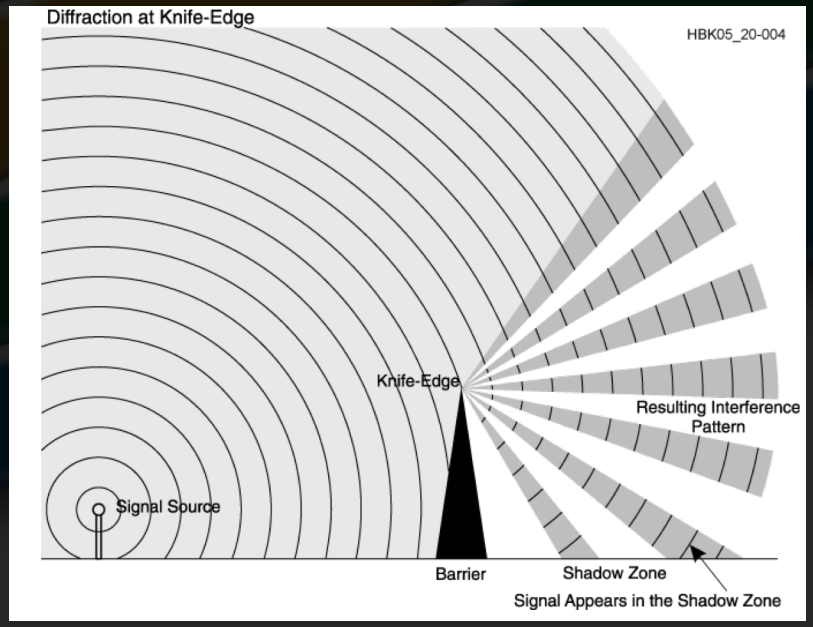
- At lower HF frequencies radio waves can follow the Earth's surface as they travel.
- These waves will travel beyond the range of line-of-sight.
- Range of a few hundred miles on bands used by amateurs.

Reflect, Refract, Diffract

- Radio waves are reflected by any conductive surface
  - Ground, water, buildings
- *Refraction* or bending occurs when waves encounter a medium having a different speed of light, such as water or an electrical feed line.

Reflect, Refract, Diffract

- *Diffraction* occurs when a wave encounters a sharp edge (*knife-edge propagation)* or corner



VHF and UHF Propagation

- Range is slightly better than visual line of sight due to gradual refraction (bending), creating the *radio horizon*.
- UHF signals penetrate buildings better than HF/VHF because of the shorter wavelength.
- Buildings may block line of sight, but reflected and diffracted waves can get around obstructions.

VHF and UHF Propagation

- *Multi-path* results from reflected signals arriving at the receiver by different paths and interfering with each other.
  - *Picket-fencing* is the rapid fluttering sound of multi-path from a moving transmitter

"Tropo" - Tropospheric Propagation

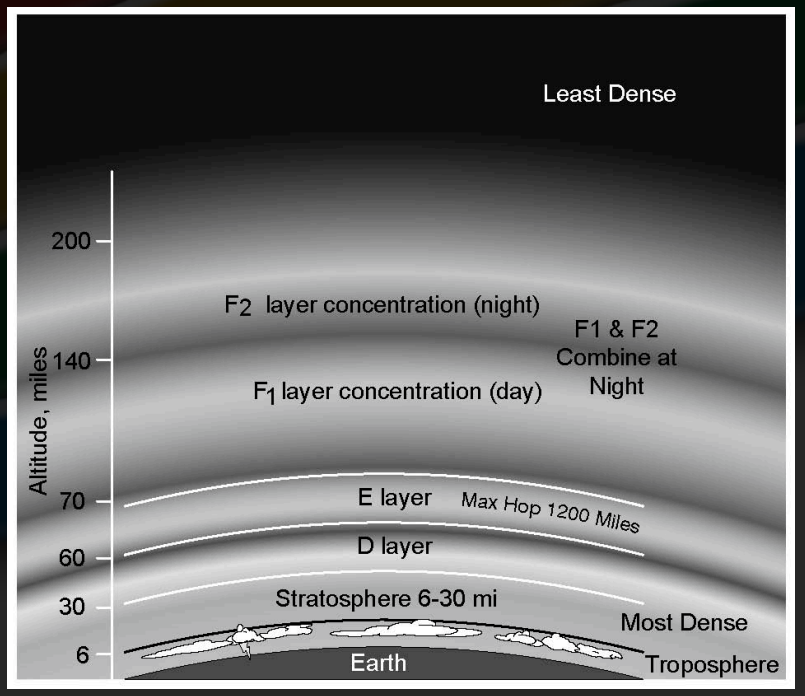
- The troposphere is the lower levels of the atmosphere – to about 30 miles high
- Radio waves can be reflected or *scattered* by clouds, rain, and density variations in the troposphere – range up to about 300 miles
- Temperature inversions and weather fronts can form *ducts* that trap and conduct VHF and UHF radio waves for hundreds of miles

The Ionosphere

- A region from 30 to 260 miles above the surface of the Earth
- Atmosphere thin enough for atoms to be ionized by solar ultraviolet radiation
- Ions are electrically conductive

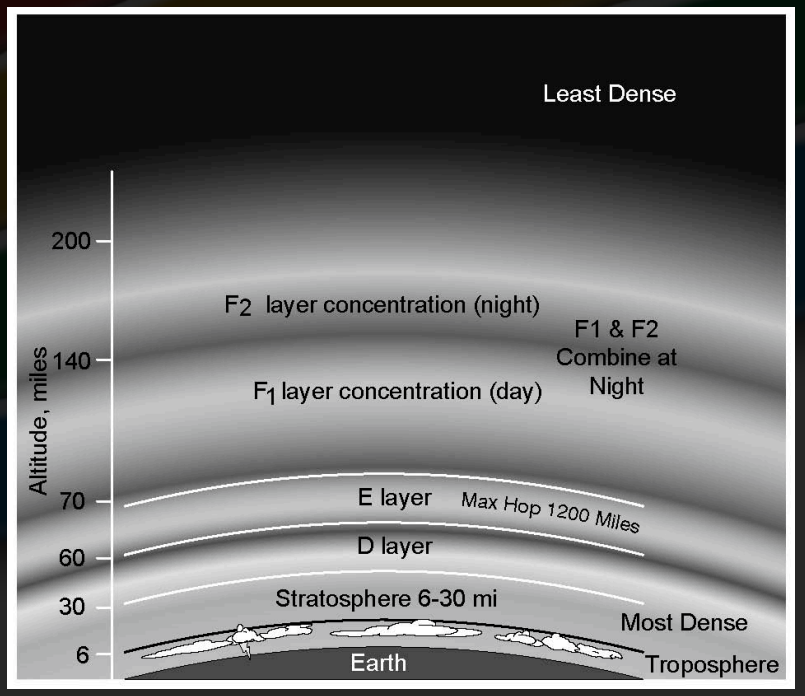
Ionospheric Levels

- Because of varying density, the ionosphere forms layers with different amounts of ionization
- Ionization varies with solar illumination (hour to hour) and intensity of solar radiation



Ionospheric Levels

- Higher ionization refracts or bends radio waves more strongly



Sunspot Cycle

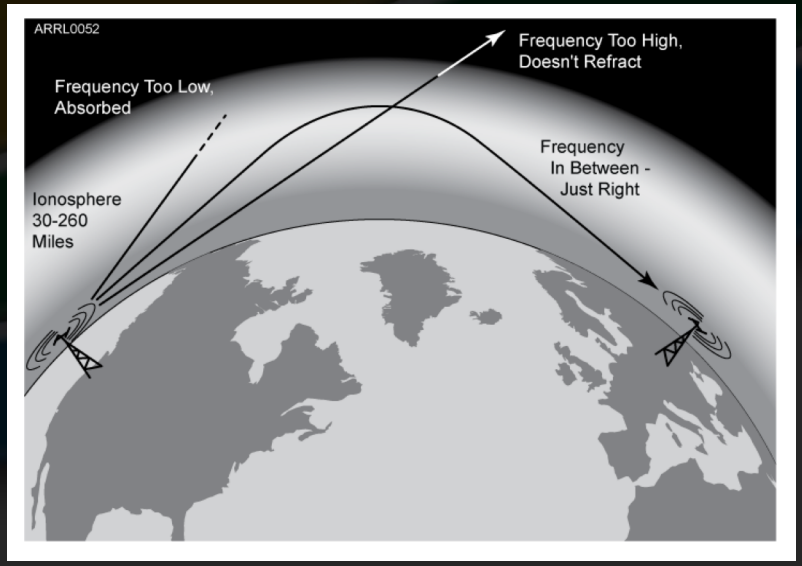
- The level of ionization depends on the intensity of radiation from the Sun.
- Radiation from the Sun varies with the number of sunspots on the Sun's surface.
  - –High number of sunspots results in high levels of ionizing radiation emitted from the Sun.
- Sunspot activity follows an 11-year cycle.

The Ionosphere – An RF Mirror

- The ionosphere can refract (bend) radio waves back to Earth – acts like reflection
- Most refraction of amateur frequencies occurs in the F layer

The Ionosphere – An RF Mirror

- Reflection depends on frequency and angle of incidence.
- Too high a frequency or angle and the waves are lost to space.



The Ionosphere – An RF Mirror

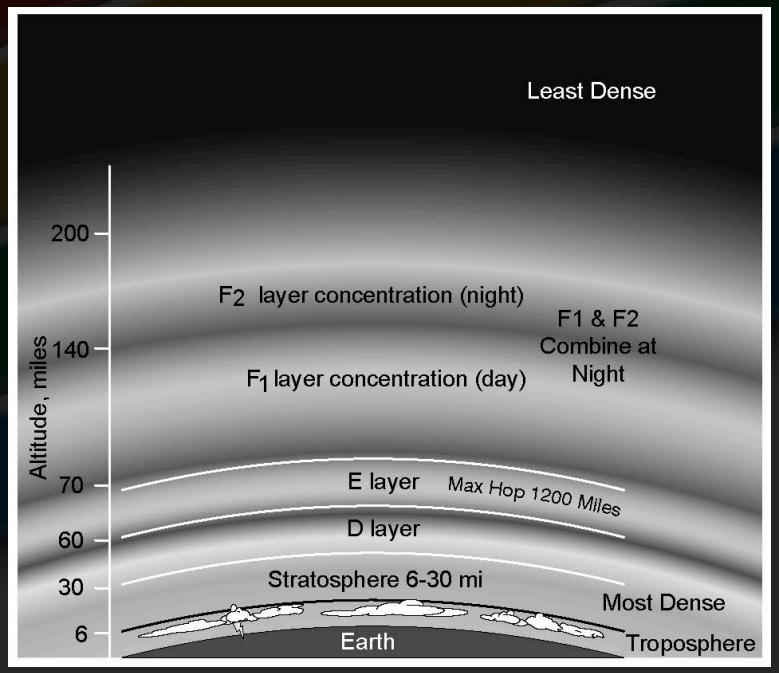
- Sky-wave or skip propagation is responsible for most over-the-horizon propagation on HF and low VHF (10 and 6 meters) during peaks of the sunspot cycle.
- Skip is very rare on the 144 MHz and higher UHF bands.
- Each ground-to-sky-to-ground trip is called a *hop*.

The Ionosphere – An RF Mirror

- Signals can take many paths through the ionosphere.
- Randomly combining at the receiving antenna, signals can partially cancel, creating irregular fading as the ionosphere changes.
  - The resulting echo and flutter distort speech and CW.
  - Fading causes data errors for digital signals.

Sporadic E (Es) and Aurora

- Highly ionized patches of the E layer can reflect HF and VHF signals – best on 10, 6, and 2 meters.
- Aurora near the north and south poles can also reflect VHF and UHF waves with a distinctive distorted sound.



Meteor Scatter

- Thousands of meteors enter the Earth's atmosphere every day – most quite small.
- Meteors leave trails of highly ionized gas that last for several seconds.
- Trails can reflect radio waves – called *meteor scatter*. The best band for this is 6 meters.
- Mostly in the E layer, meteor scatter and sporadic E supports contacts up to about 1500 miles.

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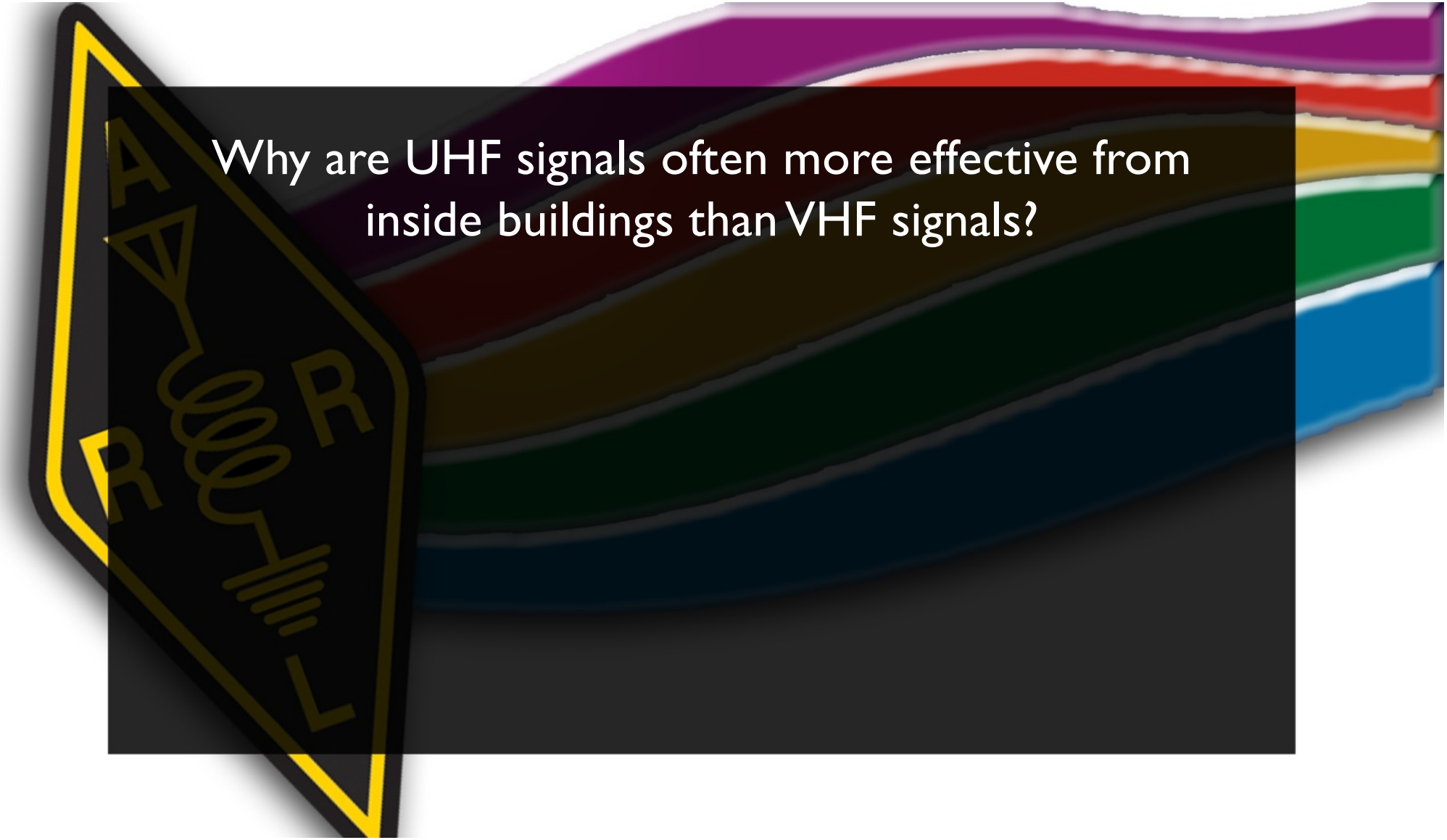
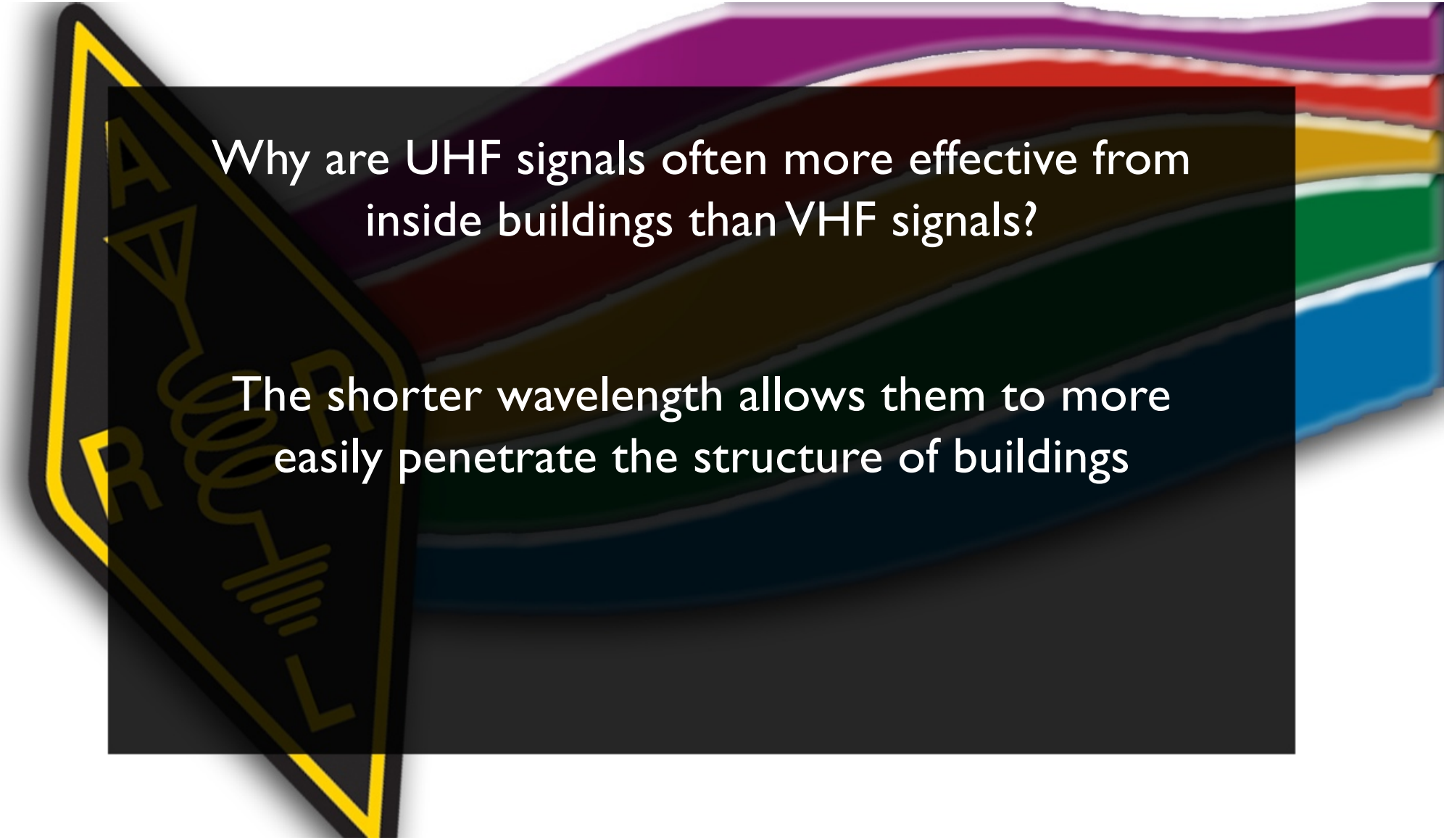
Practice Questions


What should you do if another operator reports that your station's 2 meter signals were strong just a moment ago, but now they are weak or distorted?

What should you do if another operator reports that your station's 2 meter signals were strong just a moment ago, but now they are weak or distorted?

Try moving a few feet, as random reflections may be causing multi-path distortion


Why are UHF signals often more effective from inside buildings than VHF signals?



Why are UHF signals often more effective from inside buildings than VHF signals?

The shorter wavelength allows them to more easily penetrate the structure of buildings


What term is commonly used to describe the rapid fluttering sound sometimes heard from mobile stations that are moving while transmitting?

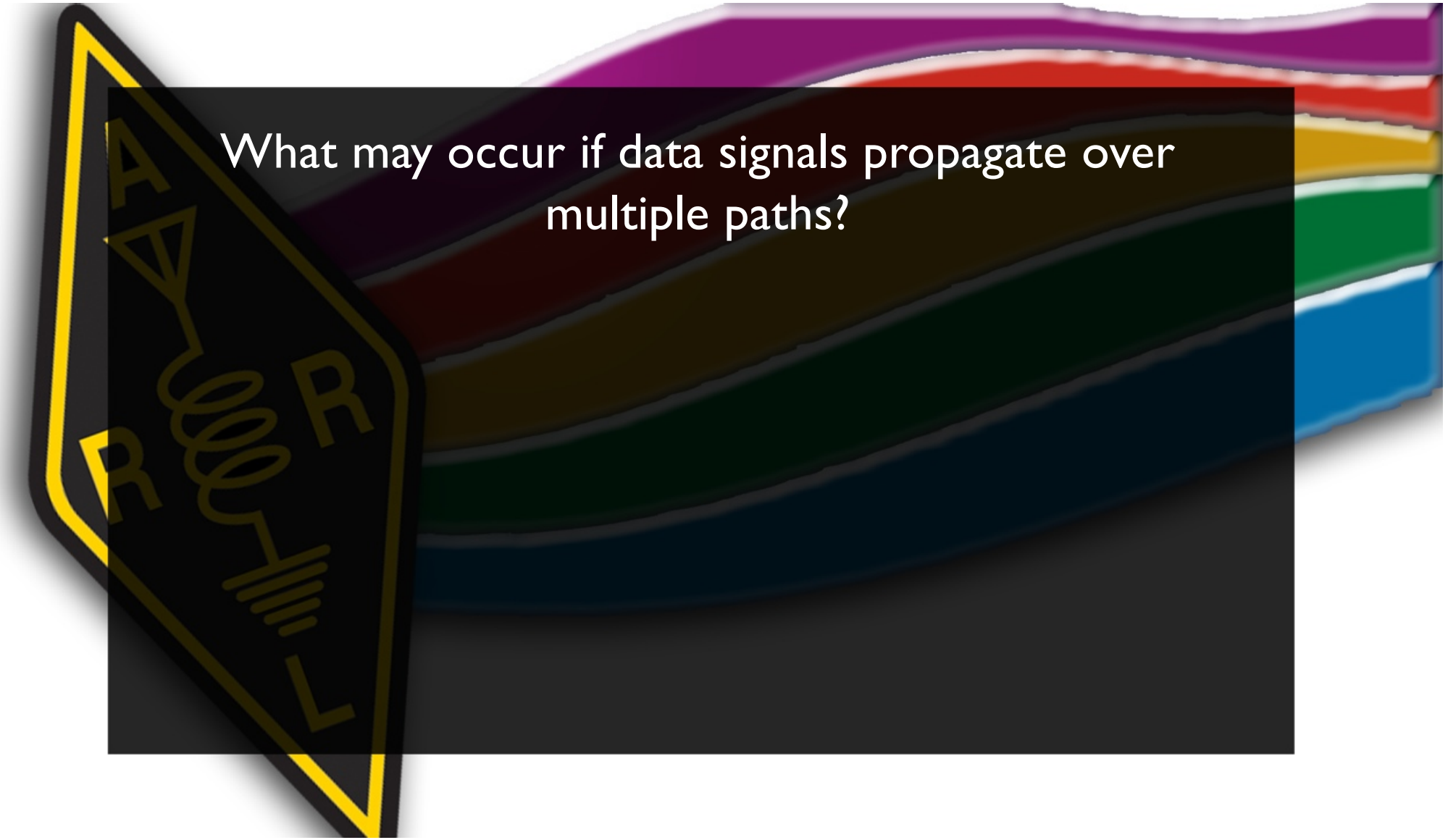
What term is commonly used to describe the rapid fluttering sound sometimes heard from mobile stations that are moving while transmitting?

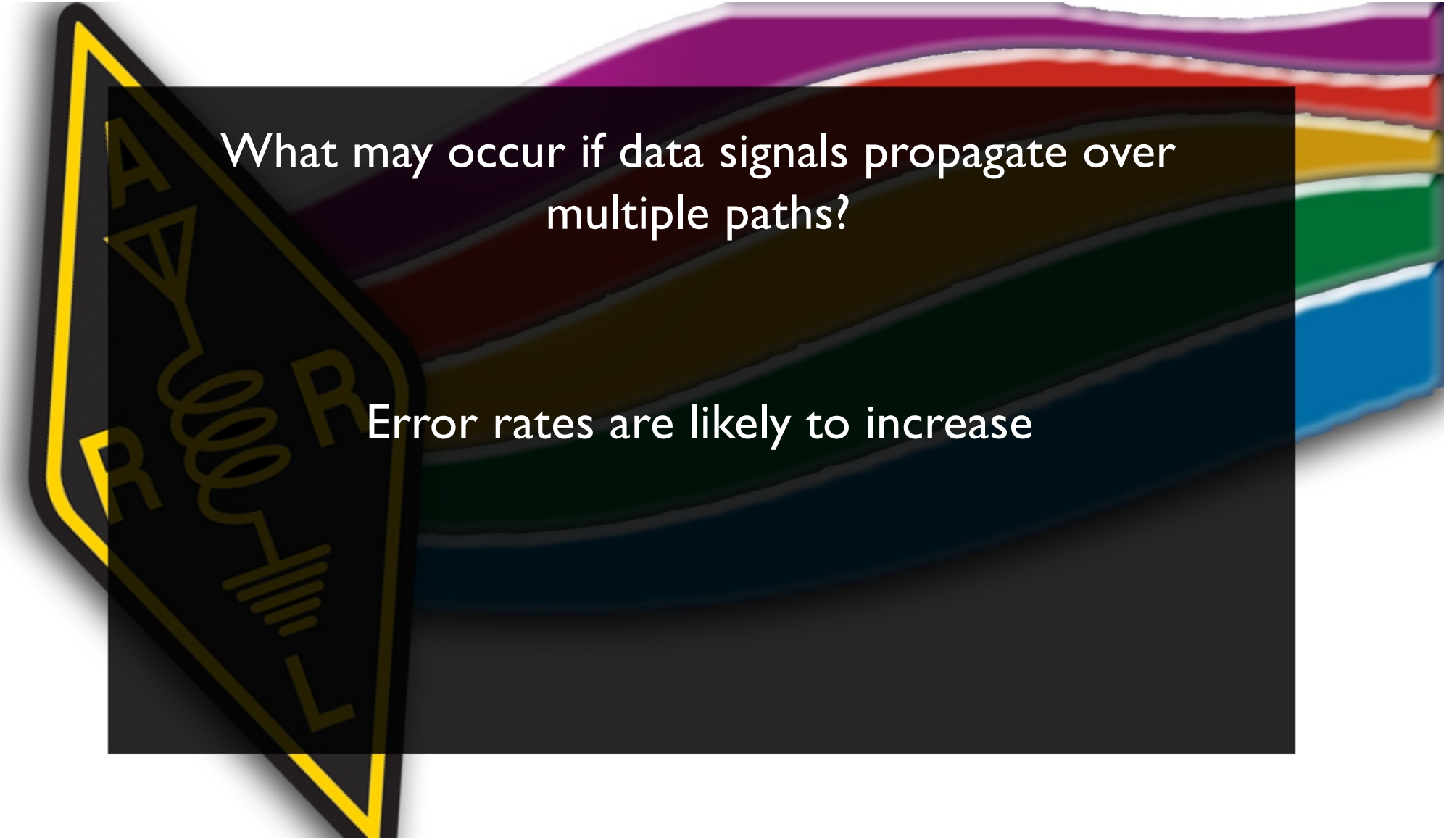
Picket fencing

Which of the following is a likely cause of irregular fading of signals received by ionospheric reflection?

Which of the following is a likely cause of irregular fading of signals received by ionospheric reflection?

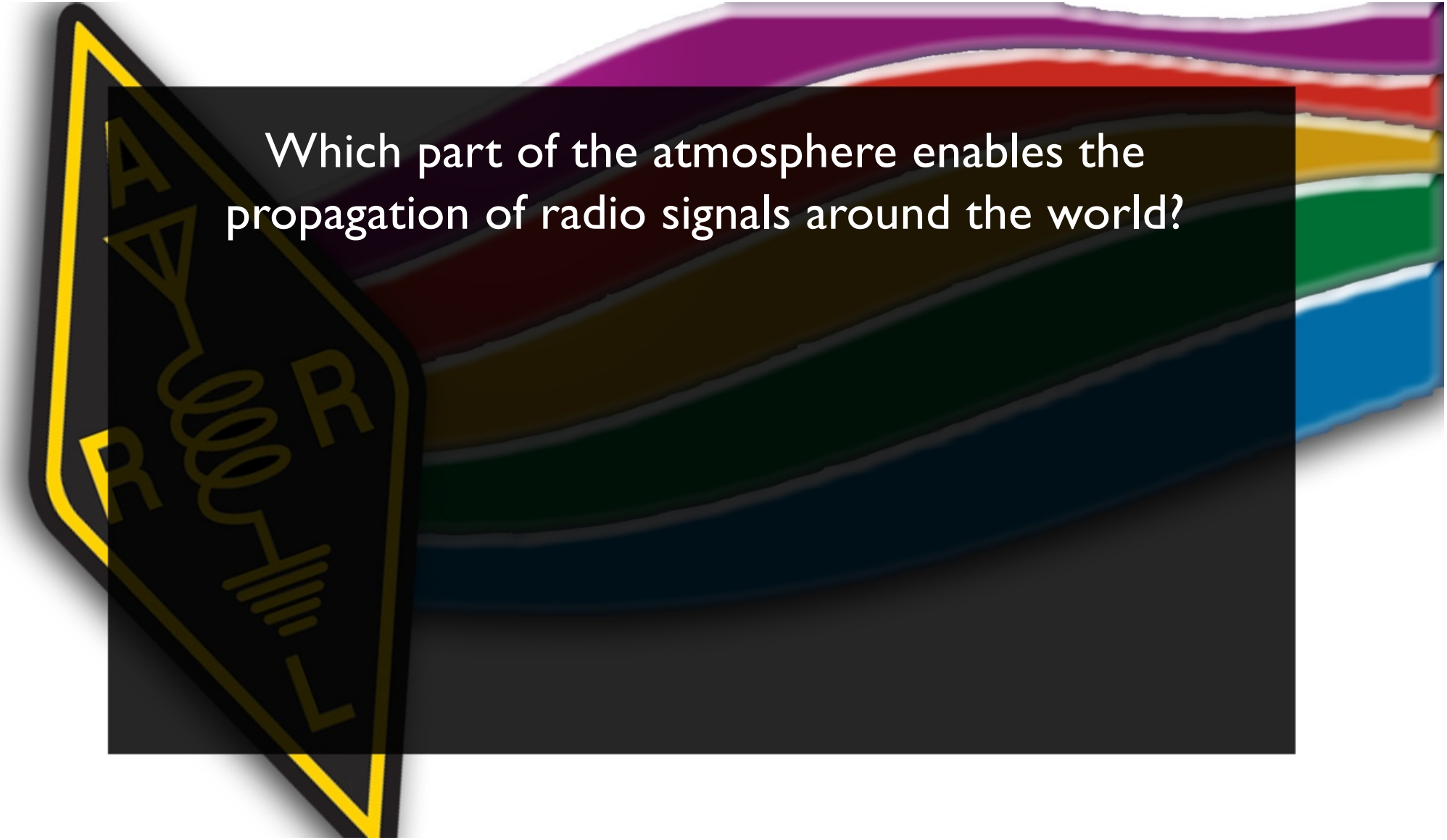
Random combining of signals arriving via different paths

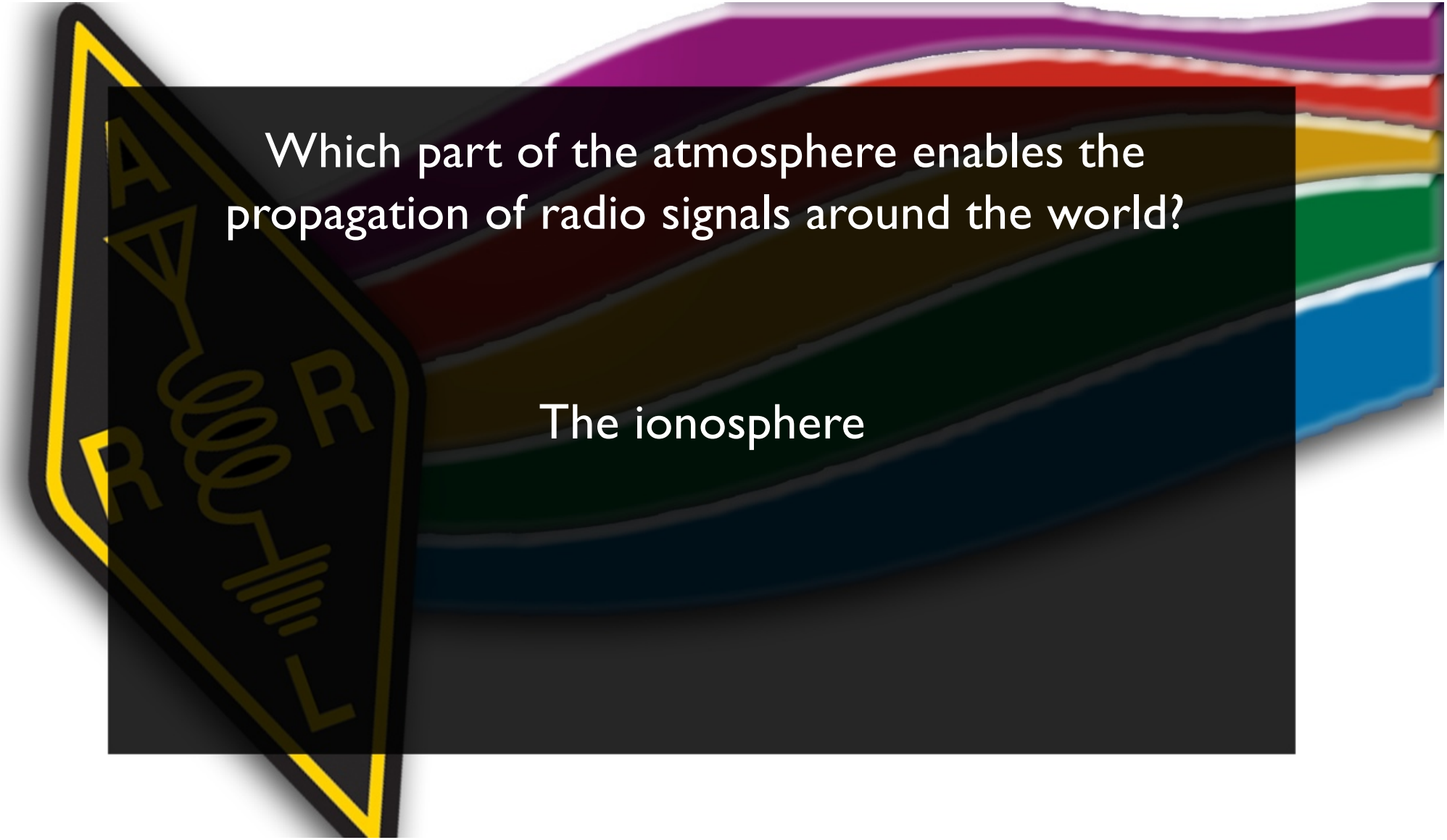

What may occur if data signals propagate over multiple paths?



What may occur if data signals propagate over multiple paths?

Error rates are likely to increase


Which part of the atmosphere enables the propagation of radio signals around the world?


Which part of the atmosphere enables the propagation of radio signals around the world?
The ionosphere


Why are direct (not via a repeater) UHF signals rarely heard from stations outside your local coverage area?

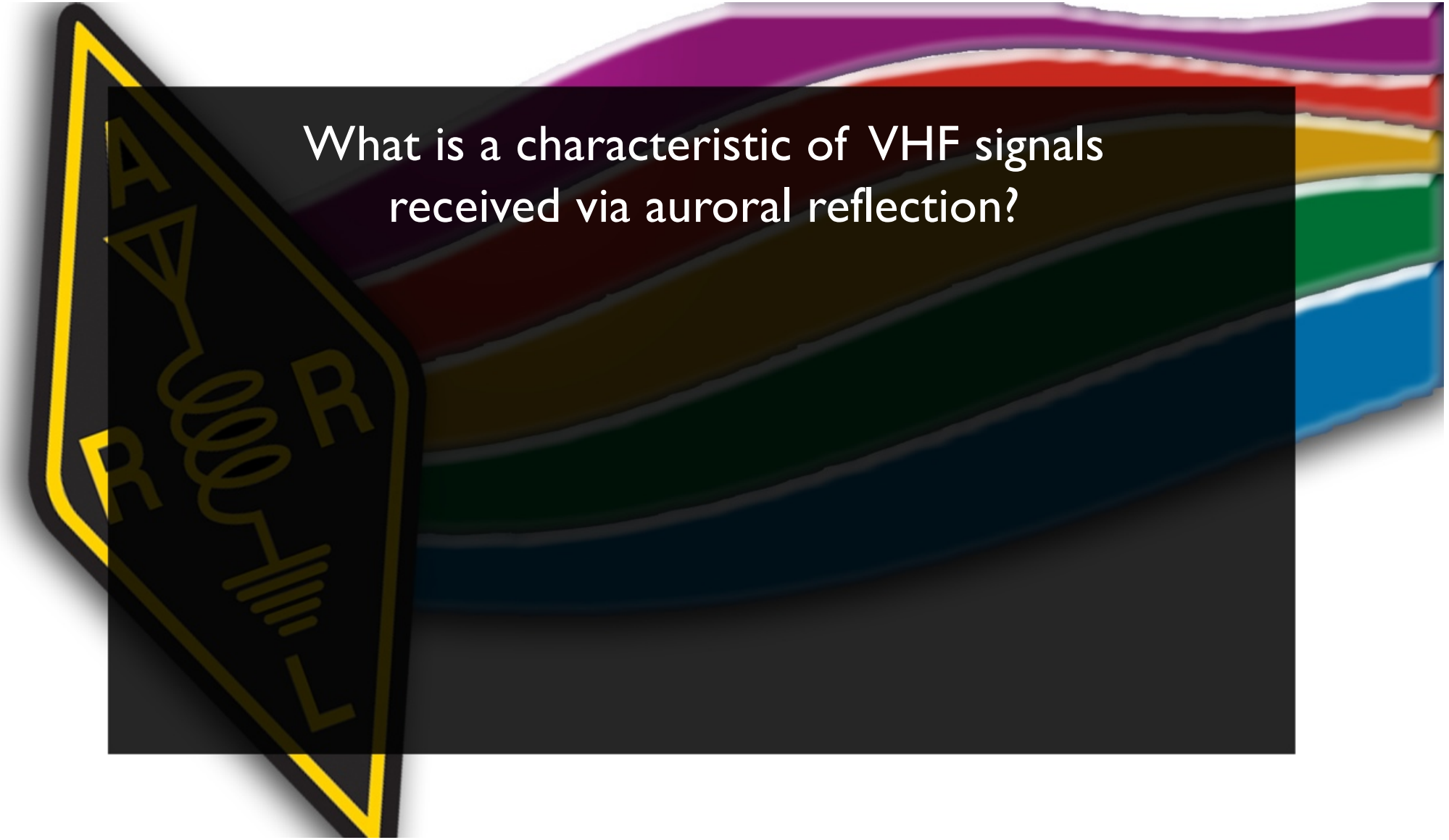
Why are direct (not via a repeater) UHF signals rarely heard from stations outside your local coverage area?

UHF signals are usually not reflected by the ionosphere


Which of the following might be happening when
VHF signals are being received from long distances?

Which of the following might be happening when VHF signals are being received from long distances?

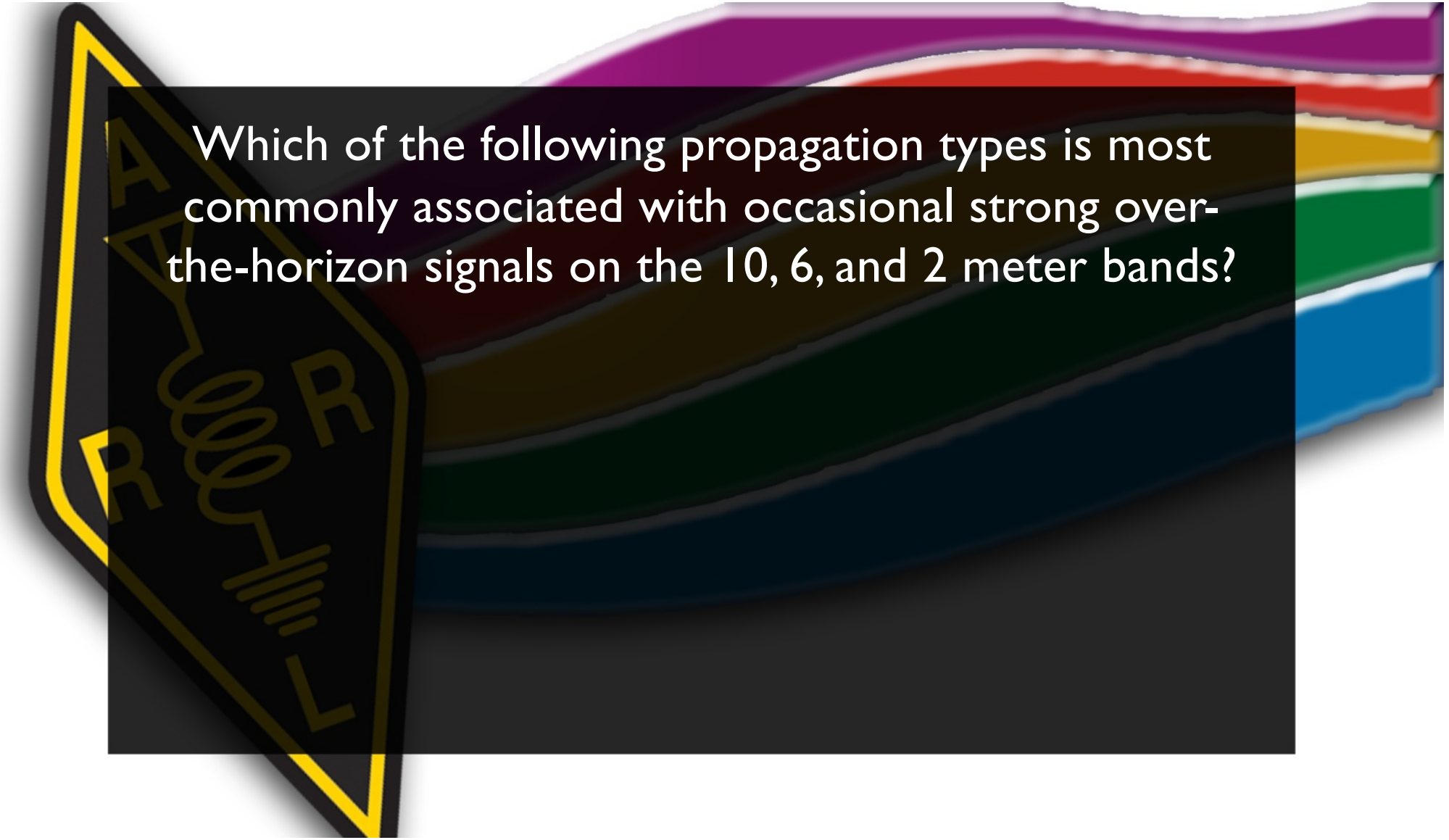
Signals are being refracted from a sporadic E layer



What is a characteristic of VHF signals received via auroral reflection?

What is a characteristic of VHF signals received via auroral reflection?

The signals exhibit rapid fluctuations of strength and often sound distorted


Which of the following propagation types is most commonly associated with occasional strong over-the-horizon signals on the 10, 6, and 2 meter bands?

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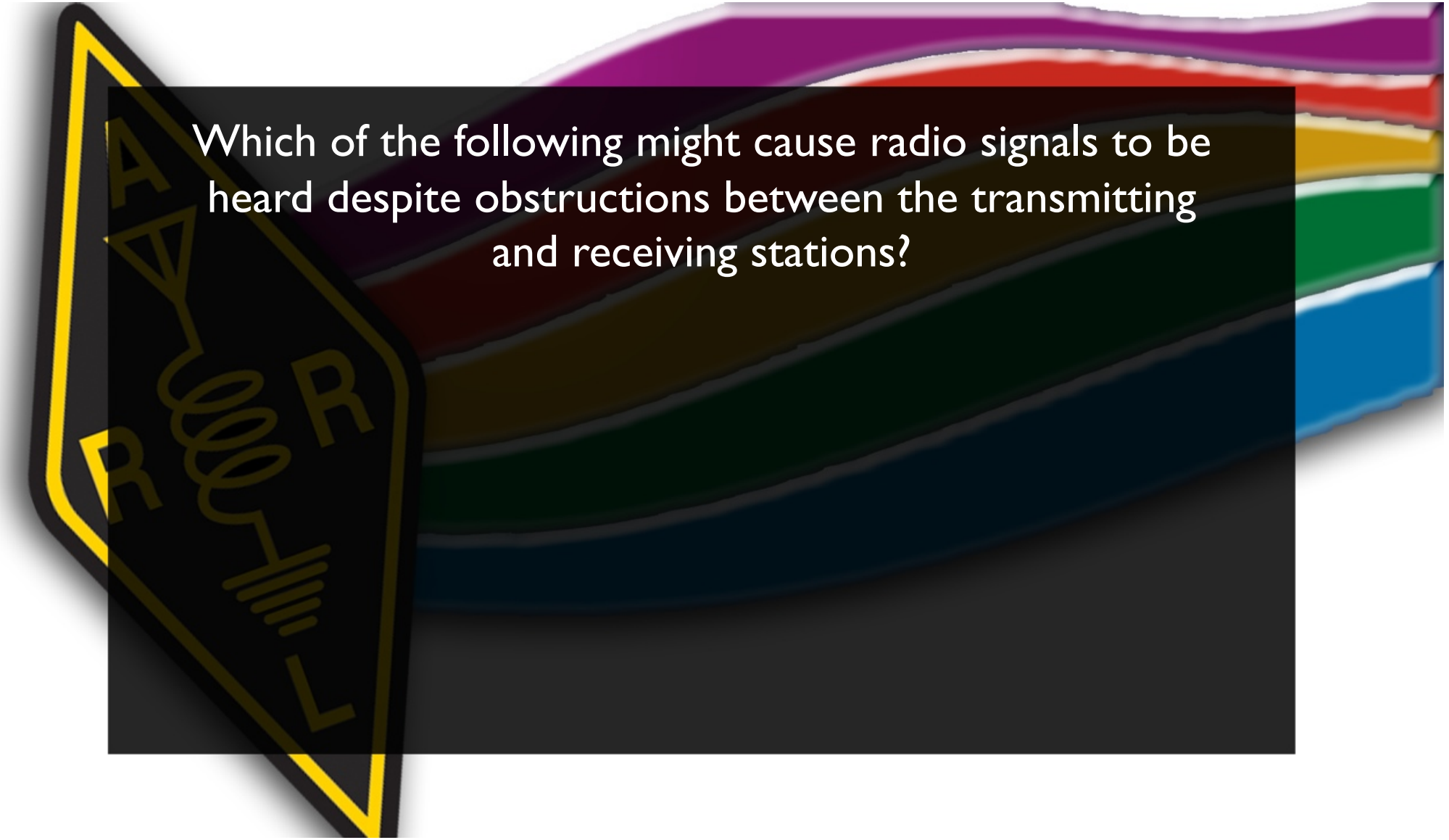
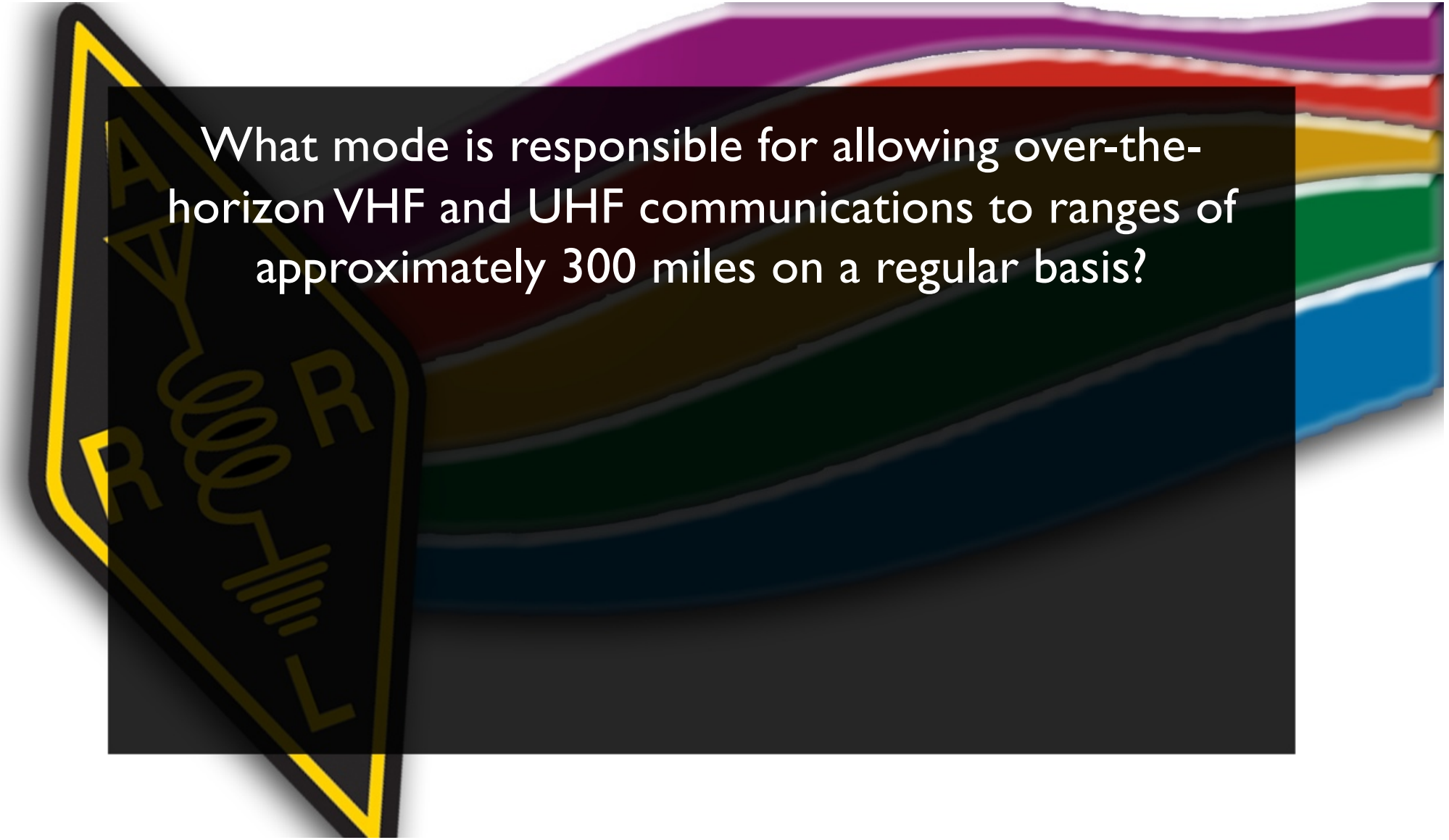
Sporadic E



Which of the following might cause radio signals to be heard despite obstructions between the transmitting and receiving stations?

Which of the following might cause radio signals to be heard despite obstructions between the transmitting and receiving stations?

Knife-edge propagation


What mode is responsible for allowing over-the-horizon VHF and UHF communications to ranges of approximately 300 miles on a regular basis?

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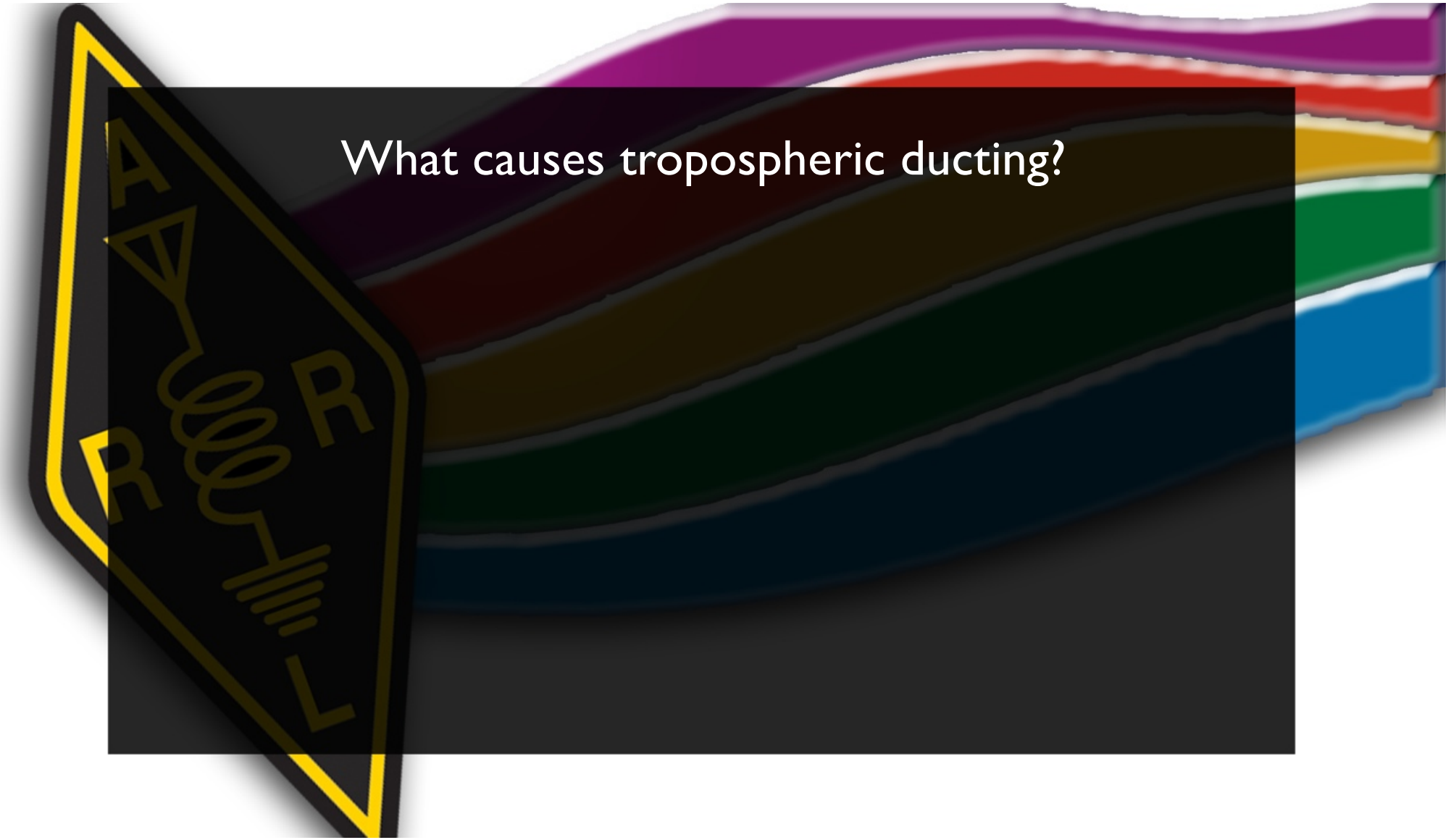
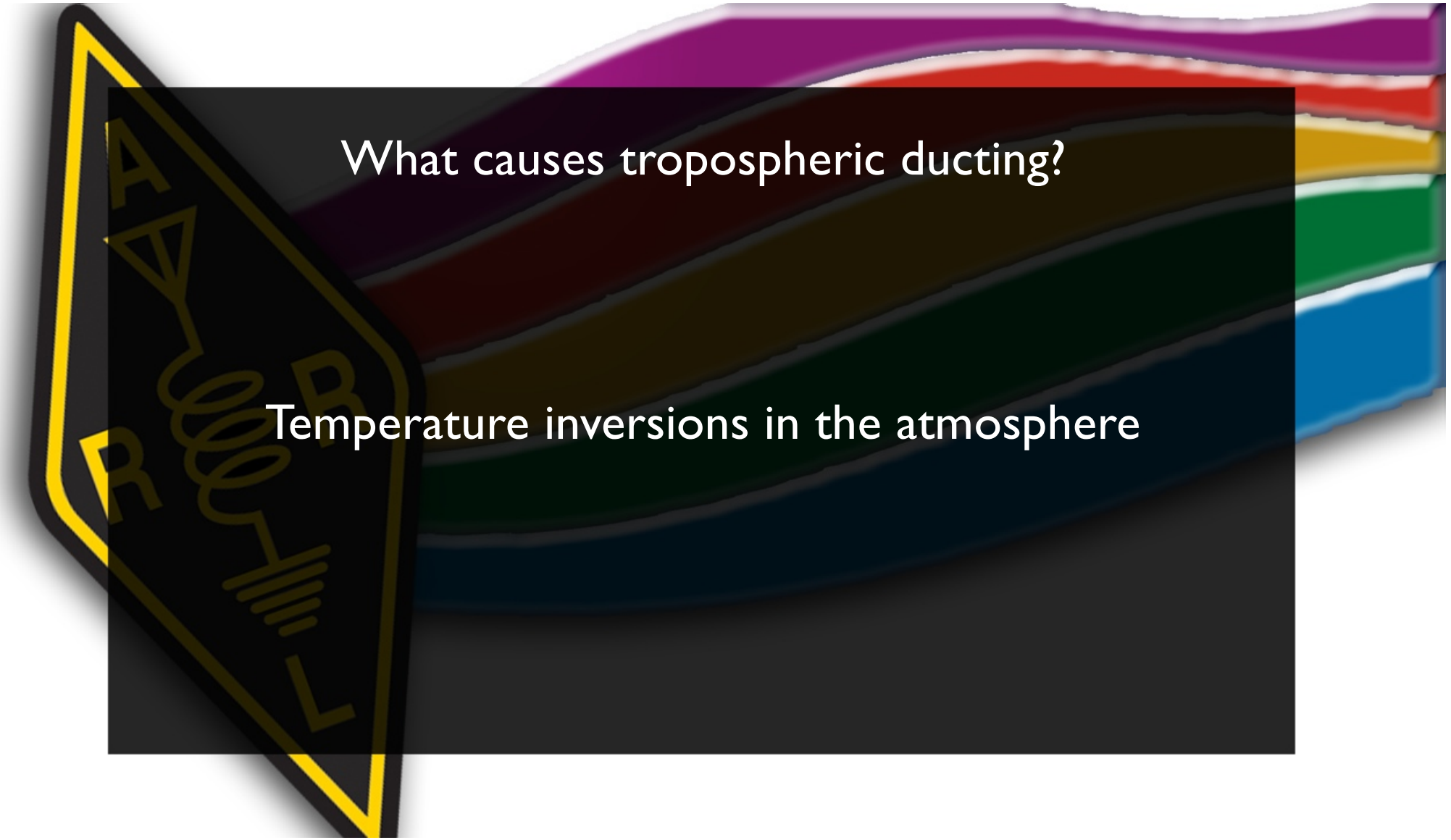
Tropospheric scatter

What band is best suited for communicating via meteor scatter?

What band is best suited for communicating via meteor scatter?

6 meters


What causes tropospheric ducting?



What causes tropospheric ducting?

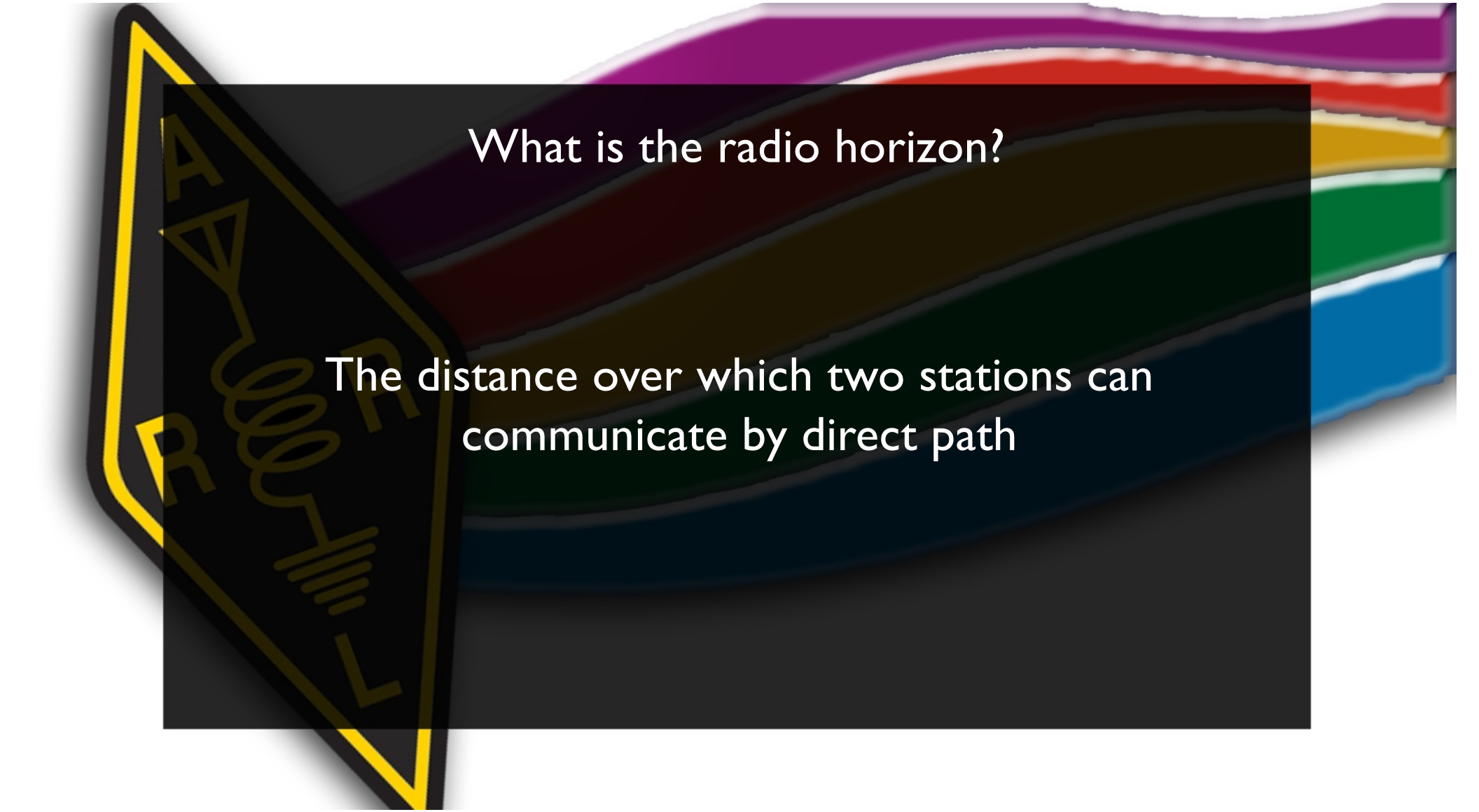
Temperature inversions in the atmosphere


What is generally the best time for long-distance 10 meter band propagation via the F layer?

What is generally the best time for long-distance 10 meter band propagation via the F layer?

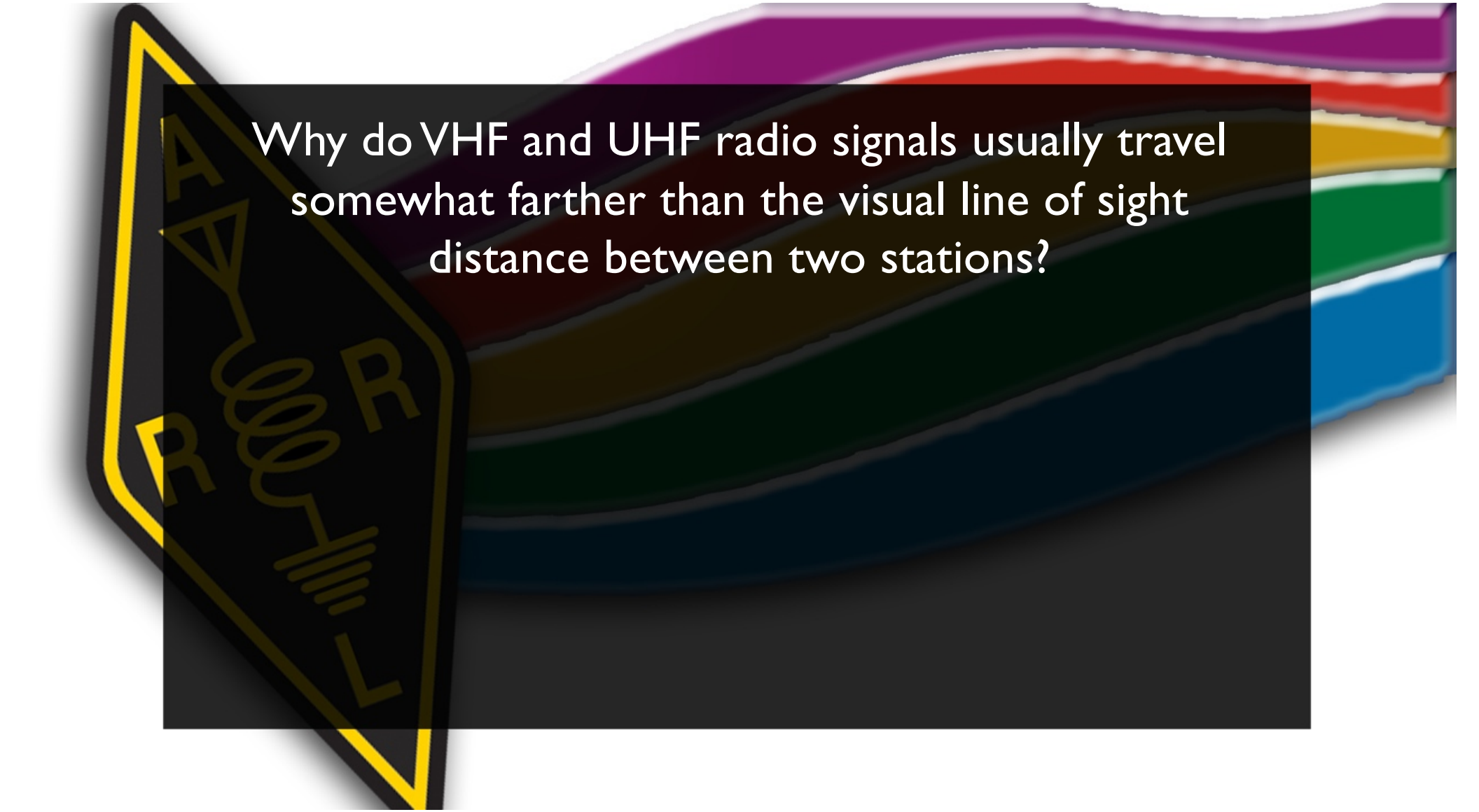
From dawn to shortly after sunset during periods of high sunspot activity


What is the radio horizon?



What is the radio horizon?

The distance over which two stations can communicate by direct path



Why do VHF and UHF radio signals usually travel somewhat farther than the visual line of sight distance between two stations?

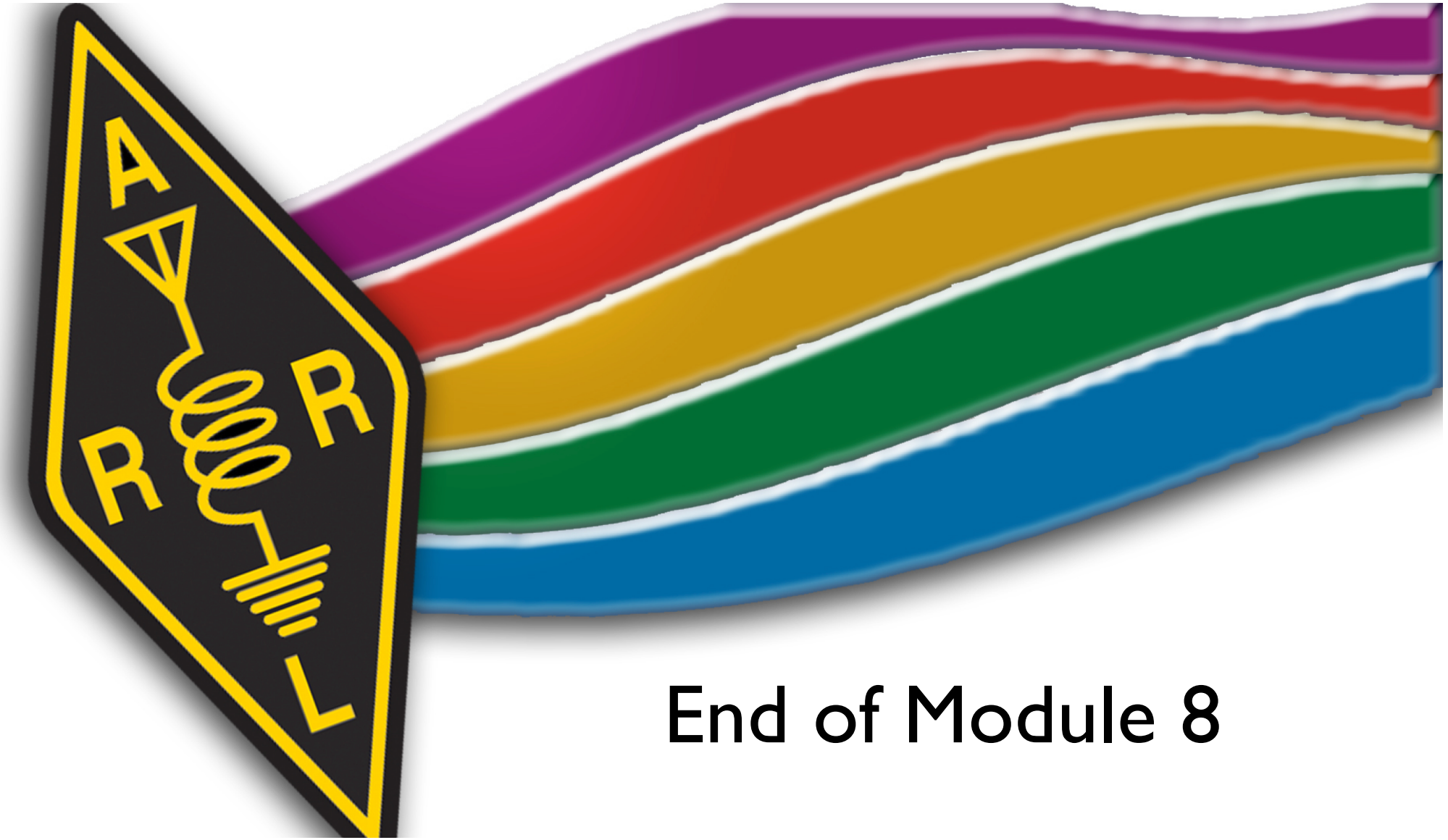
Why do VHF and UHF radio signals usually travel somewhat farther than the visual line of sight distance between two stations?

The Earth seems less curved to radio waves than to light

Which of the following bands may provide long distance communications during the peak of the sunspot cycle?

Which of the following bands may provide long distance communications during the peak of the sunspot cycle?

Six or ten meters



End of Module 8