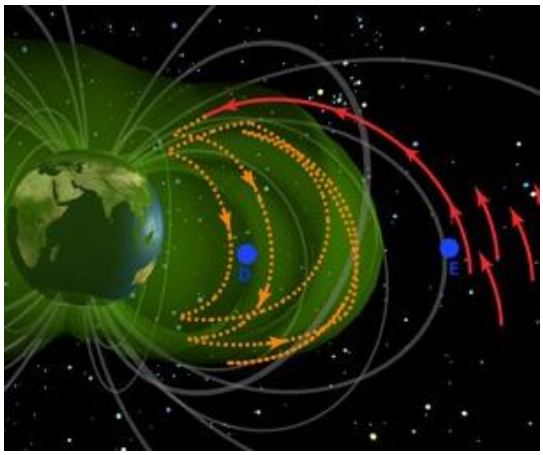

Amateur radio operators have been hearing this sound for decades, especially at 'dawn'. It is an eery sound, like a chorus of birds chirping, so it was called Dawn Chorus.

This sound cannot be heard with ordinary ears even though it is in the right frequency range. Because it is a radio wave, you need a radio receiver to hear it.

Space physicists have tried to understand what produces this electromagnetic 'sound wave', but whatever is producing it is occurring somewhere in the van Allen belts high above Earth.

During its 60-day checkout phase, the twin Van Allen Probes satellites captured chorus waves close to where they are being produced in the Van Allen belts. As the satellites continue to take more data, scientists hope to be able to triangulate the location of these waves to their place of origin. This will provide scientists with a HUGE clue about what is causing them in the first place.

Let's have a look at how they will 'triangulate' the chorus position in space using simple graphing techniques, a protractor and the Pythagorean Theorem!

Problem 1 – Suppose the two spacecraft are located at points P1 (+4.0, +2.0) for VAP-A and P2 (+5.0, -1.0) for VAP-B on a coordinate grid where Earth is at the center and each unit on the coordinate axis is an interval of 6,400 kilometers. (Note 1 unit = radius of Earth). Graph this data on a coordinate grid which has an X-domain from [-5.0, +5.0] and a y-range from [-5.0, +5.0].

Problem 2 – The RBSP-A spacecraft detects the Chorus signal coming from a direction angle of 198^{o}. RBSP-B detects the same signal coming from a direction angle of 135^{o}. Draw two lines at these angles from the locations of VAP-A and B to locate the source of the Chorus signal.

Problem 3 - What is the coordinate of the intersection point of these two lines, and the location of the Chorus signal?

Problem 4 – From the location of VAP-A, and assuming that 1-unit equals 6,400 kilometers, to the nearest hundred kilometers, about how far from the spacecraft is the source of the Chorus signal?

Problem 1 – Suppose the two spacecraft are located at points P1 (+4.0, +2.0) for VAP-A and P2 (+5.0, -1.0) for VAP-B on a coordinate grid where Earth is at the center and each unit on the coordinate axis is an interval of 6,400 kilometers. (Note 1 unit = radius of Earth). Graph this data on a coordinate grid which has an X-domain from [-5.0, +5.0] and a y-range from [-5.0, +5.0]. Answer: **See figure below**

Problem 2 – The VAP-A spacecraft detects the Chorus signal coming from a direction angle of 198^{o}. RBSP-B detects the same signal coming from a direction angle of 135^{o}. Draw two lines at these angles from the locations of VAP-A and B to locate the source of the Chorus signal. Answer: Students place the protractor centered on each spacecraft point, with the bottom edge parallel to the horizontal X-axis. They measure the two degree angles and draw a line through each point.

Problem 3 - What is the coordinate of the intersection point of these two lines, and the location of the Chorus signal? Answer: The intersection point is at **C:(+2.5, +1.5)**

Problem 4 – From the location of VAP-A, and assuming that 1-unit equals 6,400 kilometers, to the nearest hundred kilometers, about how far from the spacecraft is the source of the Chorus signal? Answer: Students can use a ruler and from this scaled drawing determine that the length of the chord from VAP-A to Point C is about 1.6 units or 1.6 x 6400 km = **10,200 kilometers.** Students may also use the distance formula $d^2 = (4.0\text{-}2.5)^2 + (2.0\text{-}1.5)^2$ so d = 1.6 units and so d = 10,200 km.