Can you solve this?

Professor Doug Stephan sent us the following problem:

Question:

The compounds \( \text{P}_5\text{Ph}_5 \) is an oligophosphine that binds in a bidentate fashion to \( \text{Rh} \). The \( ^{31}\text{P} \) spectrum (see aside) is shown. Can you rationalize the observation of inequivalent \( \text{P} \) atoms?

Answer:

The \( ^{31}\text{P} \{^1\text{H} \} \) NMR spectrum is a remarkably well resolved, yet complex pattern exhibiting five sets of resonances ranging from 55 to -15 ppm (Fig. 1), consistent with the presence of five distinct \( \text{P} \) environments. NMR spectral data revealed the couplings of each of the \( \text{P} \) atoms to other \( \text{P} \) nuclei as well as \( \text{Rh} \) with coupling constants ranging from 2–365 Hz. The extracted coupling constants were employed to simulate the first-order ABCDEX \( ^{31}\text{P} \{^1\text{H} \} \) NMR spectrum. This is consistent with The \( \text{P}_5 \)-ring is bound to \( \text{Rh} \) in a 1,3 fashion with two of the five \( \text{P} \) nuclei are above the \( \text{Rh} \) coordination plane while only one \( \text{P} \) atom is below. The inequivalence of the two sides of the coordination plane a result from the orientation of the Ph rings on the \( \text{P} \) atoms. Of the two \( \text{P} \) atoms above the coordination plane, \( \text{P}(5) \) has a Ph ring oriented toward the \( \text{Rh} \), while the Ph ring on \( \text{P}(4) \) is oriented away.