

Out-of-Class Questions

Article: C.N. LaFratta, I. Pelse, J.L. Falla, M.A. Palacios, M. Manesse, G.M. Whitesides, and D.R. Walt, "Measuring atomic emission from beacons for long-distance chemical signaling," *Anal Chem.* **2013**, 85, 8933-8936.

1. Define "infochemistry".
2. In this paper, the salts are atomized by combustion (i.e., a flame). What other methods for atomization for atomic emission are available?
3. A methanol and air flame like the one used here typically obtains a maximum temperature of 2000 °C. What is the maximum temperature of an ICP? Why are high temperatures necessary for AES?
4. Read section 10C-1 on p. 273 of the textbook. Why did the authors use alkali metals, instead of other elements, for this application?

5. What do the authors mean when they say the signal is “isotropic”? How is isotropic emission an advantage for this application?

6. In the custom telescope in Figure 2, what components act as wavelength selectors? What wavelength selector is typically used in AES instrumentation? Explain the advantages of these two types of wavelength selectors for each application.

7. What signal processing method was used on the data in Figure 3? What are the advantages of this method for this application?

8. Estimate the signal-to-noise ratio of the processed cesium signal in the top right panel of Figure 6.

9. Go to the *NIST Handbook of Basic Atomic Spectroscopic Data* and look up the most intense persistent strong line(s) between 700-900 nm for Na, Li, and Ca in air. Lines indicated “P” next to the intensity refer to persistent lines, which are detectable even for low concentrations of the element in the presence of other species.

<http://www.nist.gov/pml/data/handbook/index.cfm#>

10. Peruse the bandpass filters available from Spectrofilm.com (the vendor used for parts in this manuscript). What is the narrowest range of wavelengths that can be passed by these commercial filters? How does this compare to the width of an atomic emission line?

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1. Consider Figure 4.
 - a. Show the calculation used to determine the distance limit of detection of 1.7 km.
 - b. If the authors wanted to double the distance limit of detection, by what factor would the intensity of the atomic emission need to be increased?
 - c. Is it reasonable to expect that this increase in intensity (needed to double the distance limit of detection) could be achieved by increasing the concentration of the metal salts? Explain your answer.

2. In the top panels of Figure 6, why is it that the cesium signal can be the highest magnitude in the raw data, but is at the "low" level after decoding in the processed data?

3. What is the purpose of the instrument response matrix and what factors affect it?

4. The authors suggest that greater information density could be achieved by adding Na, Li, and Ca to the signal. Do you think that this would be feasible? Support your answer using the information you looked up for out-of-class questions 9 and 10.

5. The authors suggest that this beacon could be used to transmit data in resource-poor environments, such as natural disaster sites. Evaluate the feasibility of this application given the information in the manuscript.