Chemists Should Write Like Journalists and Speak Like Cavemen

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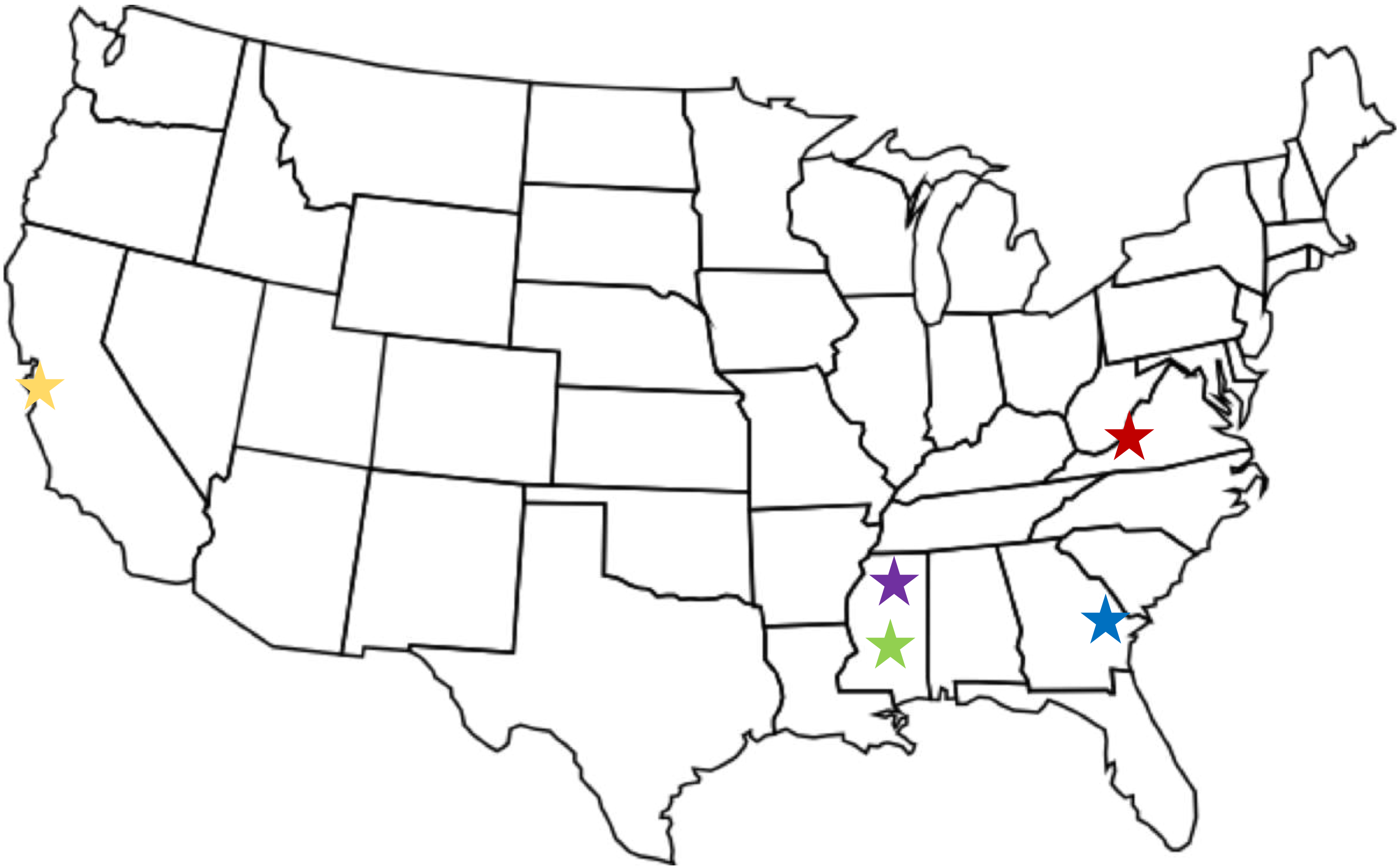

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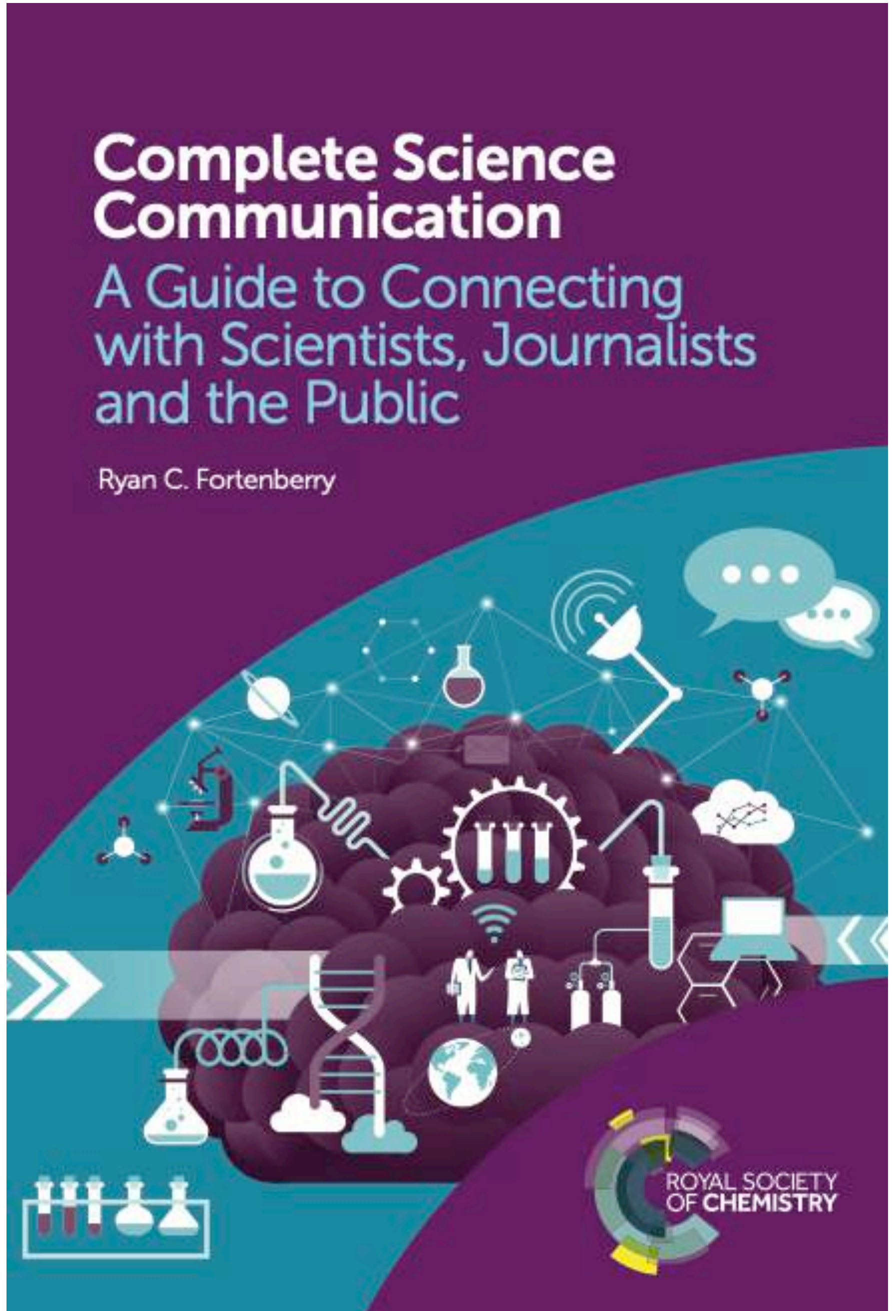

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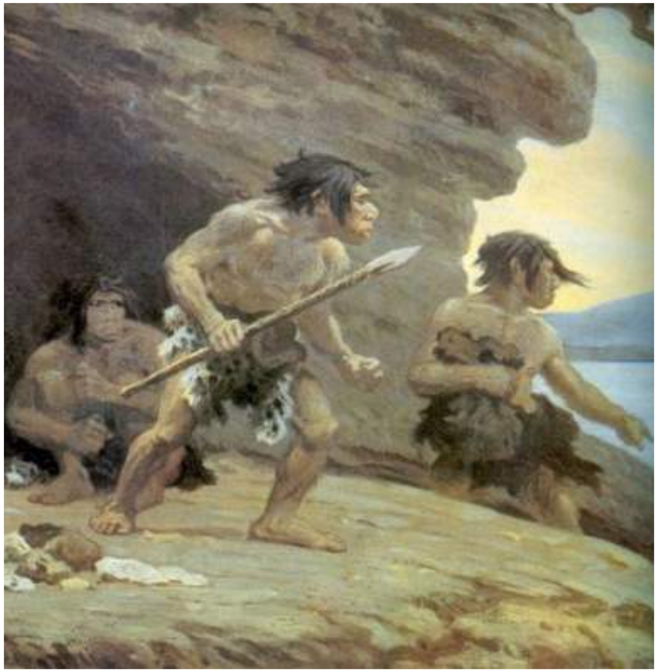
Scientists Should . . .

Write



SPEAK

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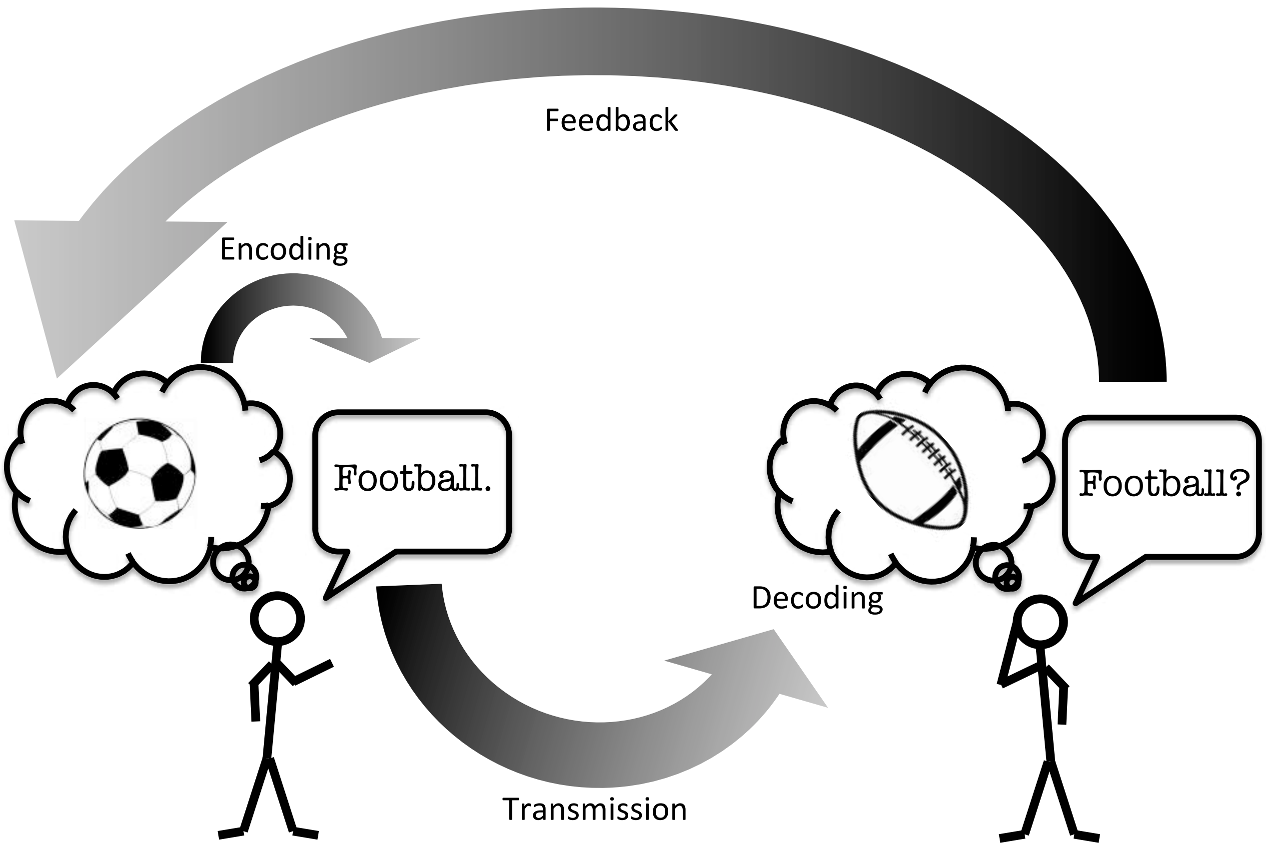
Shannon-Weaver Model of Human Communication



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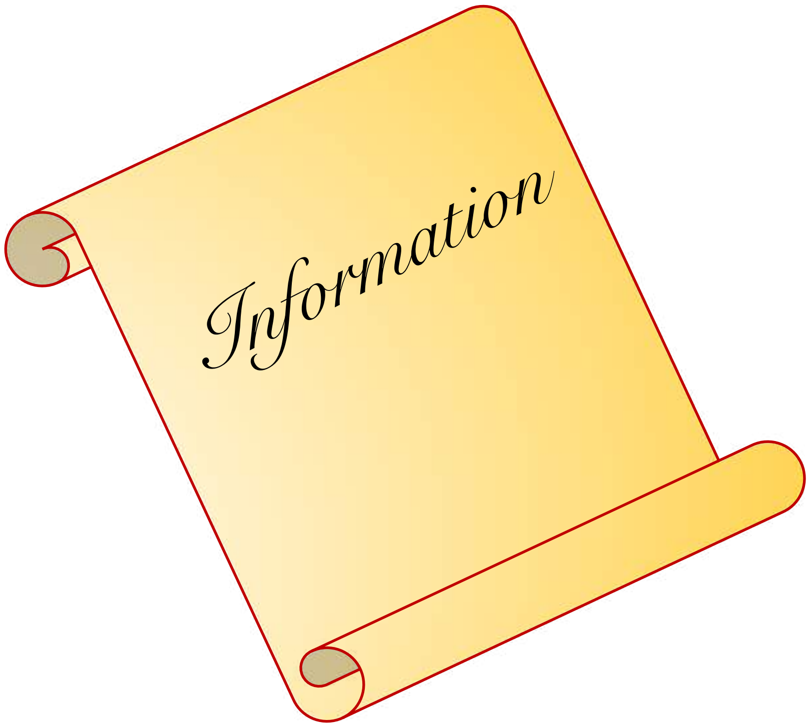

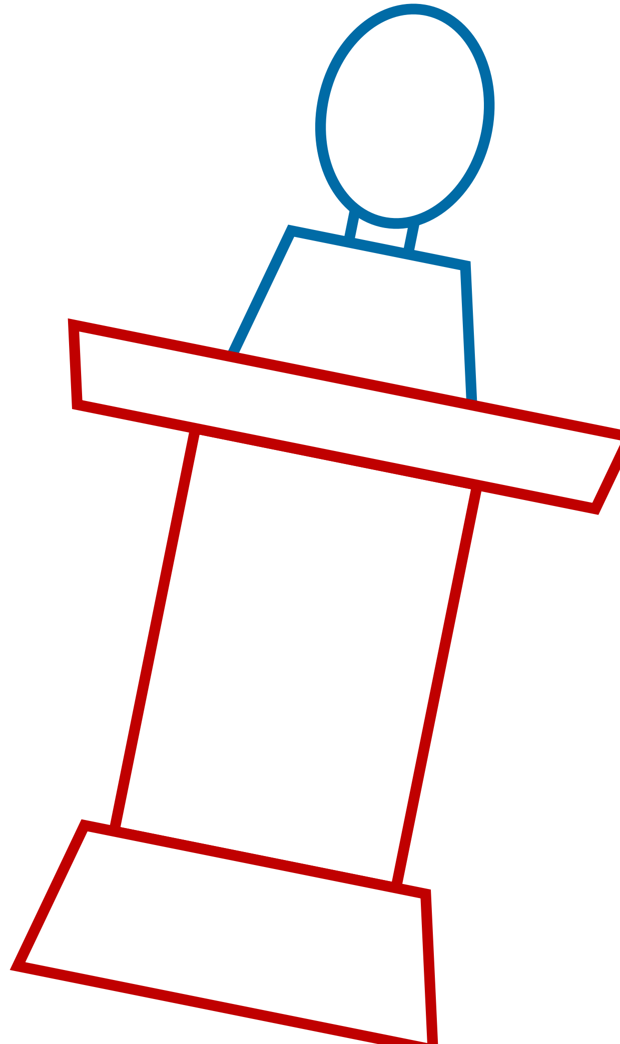

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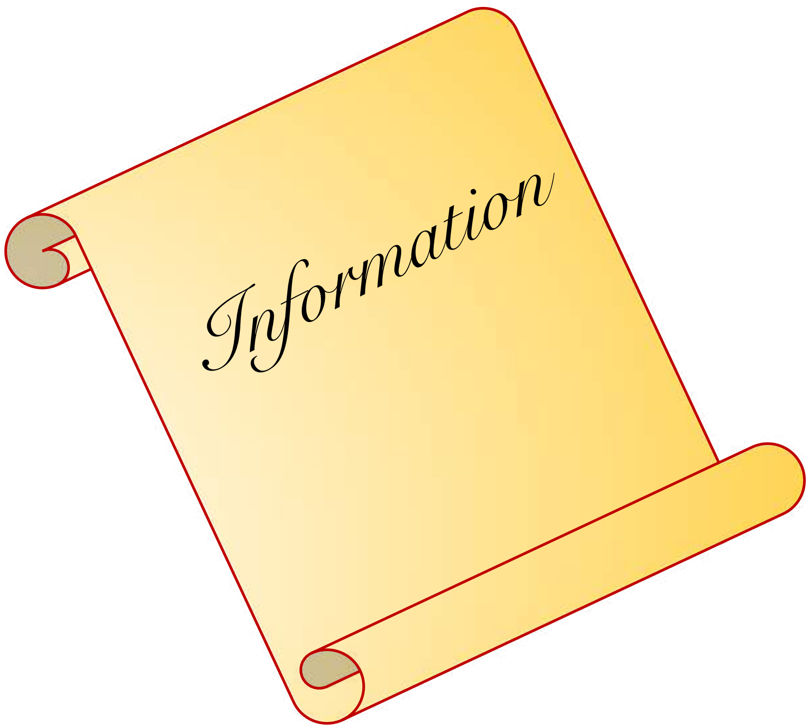

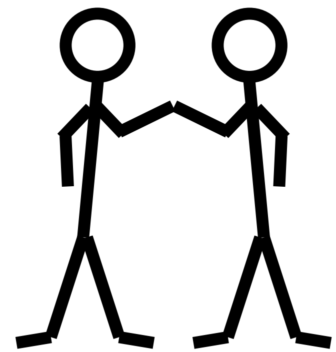

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The 5 Ws

1. Who
2. What
3. When
4. Where
5. hoW

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The 3 Cs

1. Clear
2. Concise
3. Correct

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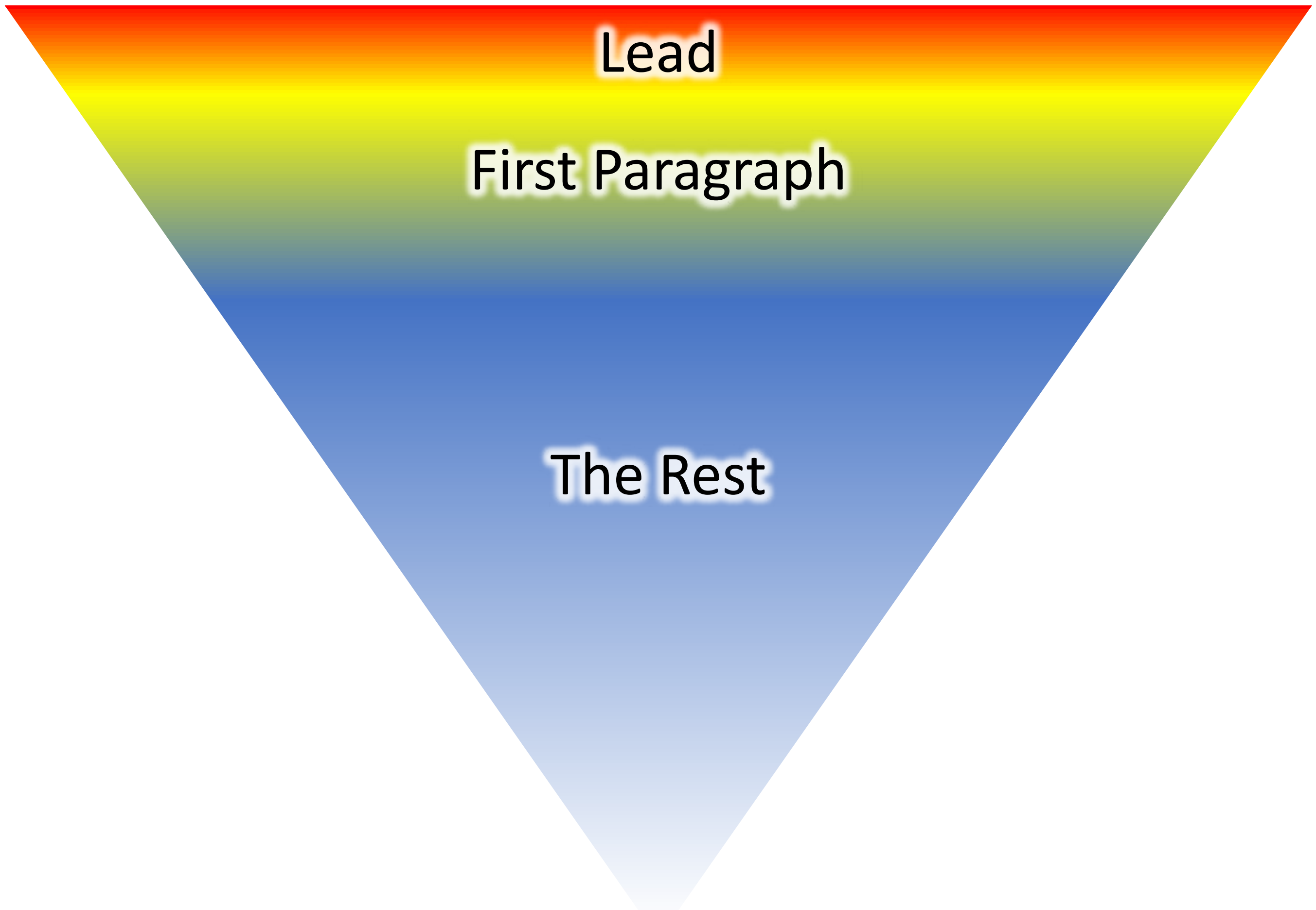
Journalist's Inverted Pyramid



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Remember:

1. 3^{rd} person
2. present tense
3. active voice
4. omniscient viewpoint

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Other Items:

1. Subject, Action, Object
2. No “It is” EVER!
3. No “we”.

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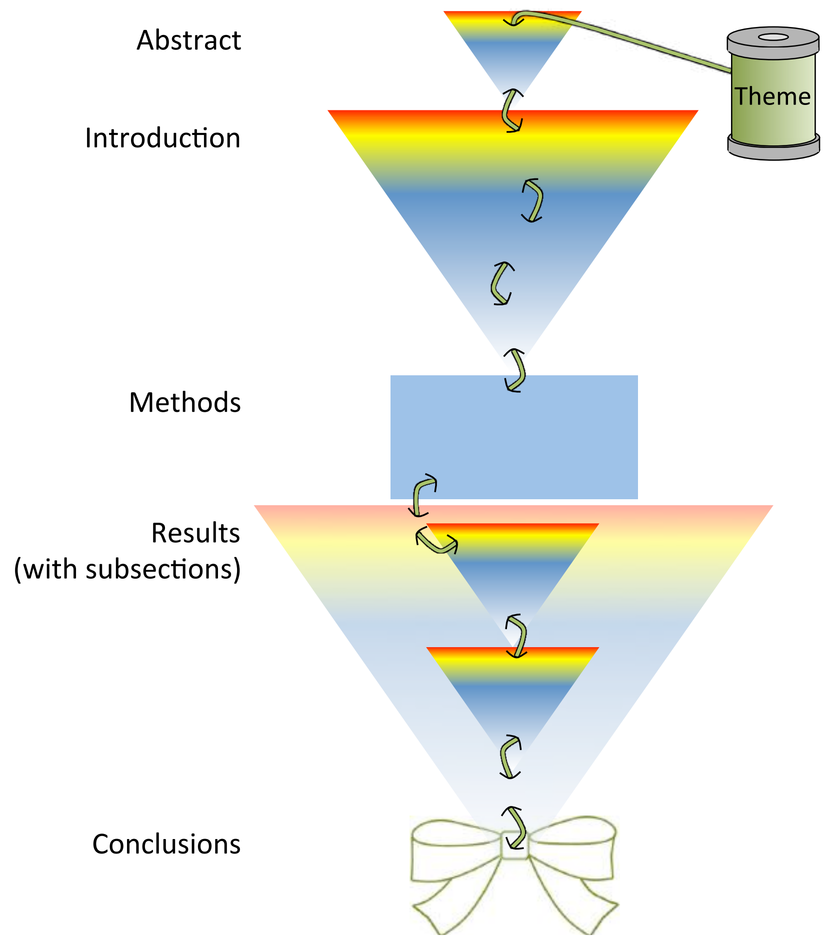
“Journalistic Structure of Scientific Paper”



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The interstellar formation and spectra of the noble gas, proton-bound $HeHHe^+$, $HeHNe^+$ and $HeHAr^+$ complexes

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ABSTRACT

The sheer interstellar abundance of helium makes any bound molecules or complexes containing it of potential interest for astrophysical observation. This work utilizes high-level and trusted quantum chemical techniques to predict the rotational, vibrational and rovibrational traits of $HeHHe^+$, $HeHNe^+$ and $HeHAr^+$. The first two are shown to be strongly bound, while $HeHAr^+$ is shown to be more of a van der Waals complex of argonium with a helium atom. In any case, the formation of $HeHHe^+$ through reactions of HeH^+ with $HeH_3{}^+$ is exothermic. $HeHHe^+$ exhibits the quintessentially bright proton-shuttle motion present in all proton-bound complexes in the 7.4 micron range making it a possible target for telescopic observation at the mid-/far-Infrared crossover point and a possible tracer for the as-of-yet unobserved helium hydride cation. Furthermore, a similar mode in $HeHNe^+$ can be observed to the blue of this close to 6.9 microns. The brightest mode of $HeHAr^+$ is dimmed due the reduced interaction of the helium atom with the central proton, but this fundamental frequency can be found slightly to the red of the Ar–H stretch in the astrophysically detected argonium cation.

This material is based on work supported by the National Science Foundation under Grant No. 1757220.

1 INTRODUCTION

Helium and hydrogen make up nearly all of the observable matter in the Universe leaving chemists to squabble over the remaining scraps. These scraps are what compose the planets, our bodies and most other things engineered by human beings. Nearly all other processes depend upon atoms much more interesting than the first two on the periodic table. Even so, helium and hydrogen can engage in chemistry with one another almost certainly combining to make HeH^+ (Hogness & Lunn 1925). This cation should be produced in detectable amounts if for no other reason than the sheer abundance of the constituents in the interstellar medium (ISM; Roberge & Dalgarno 1982). However, such an interstellar observation of this diatomic cation has yet to be reported in the literature. It was the analogous ArH^+ that has been observed towards various astronomical sources(Barlow et al. 2013; Roueff, Alekseyev & Bourlot 2014; Schilke et al. 2014; Neufeld & Wolfire 2016) making the argonium and not helonium (helium hydride) cation the first noble gas molecule detected in nature. The smaller and more abundant helium and even neon hydride cations have not been observed, yet.

The chemistry of helium is likely the least voluminous for any of the elements between hydrogen and iron even in controlled laboratory conditions. However, helium will make complexes and form some bonds. Helium cationic clusters have been predicted, $He_mH_n{}^+$ clusters have been synthesized, dication complexes observed and even hydrogen-like replacement structures analysed (Frenking & Cremer 1990; Roth, Dopfer & Maier 2001; Grandinetti 2004; Savic et al. 2015; Zicler et al. 2016). In all cases, the issue is that the helium cation binding in any of these complexes is relatively weak making long-lifetime molecules and high enough abundances for observable interstellar spectra of such chemical combinations quite unlikely.

Like unto helium, neon is reluctant to form bonds. There is little surprise here due to the high ionization potentials and relatively poor polarizabilities in these smallest of noble gas compounds (Taylor et al. 1989; Rice et al. 1991; Pauzat & Ellinger 2005, 2007; Pauzat et al. 2009, 2013). Neonium (NeH^+) has been well-characterized (Ram, Bernath & Brault 1985; Matsushima et al. 1998; Gamallo, Huarte-Larranaga & González 2013; Coxon & Hajigeorgiou 2016; Koner et al. 2016), but it has yet to be conclusively observed in any astrophysical environment. While the reaction of Ar^+ with ubiquitous hydrogen gas leads to ArH^+ and hydrogen atoms in the ISM, the analogous reaction with neon will initially lead to neutral neon atoms and ionized hydrogen gas (Theis, Morgan & Fortenberry 2015). More complicated neon structures beyond NeH^+ have been proposed and even synthesized, but few have bond strengths in the covalent range (Frenking & Cremer 1990; Grandinetti 2011). Notable exceptions include $NeOH^+$ and $NeCCH^+$ recently characterized theoretically at high level (Theis & Fortenberry 2016;

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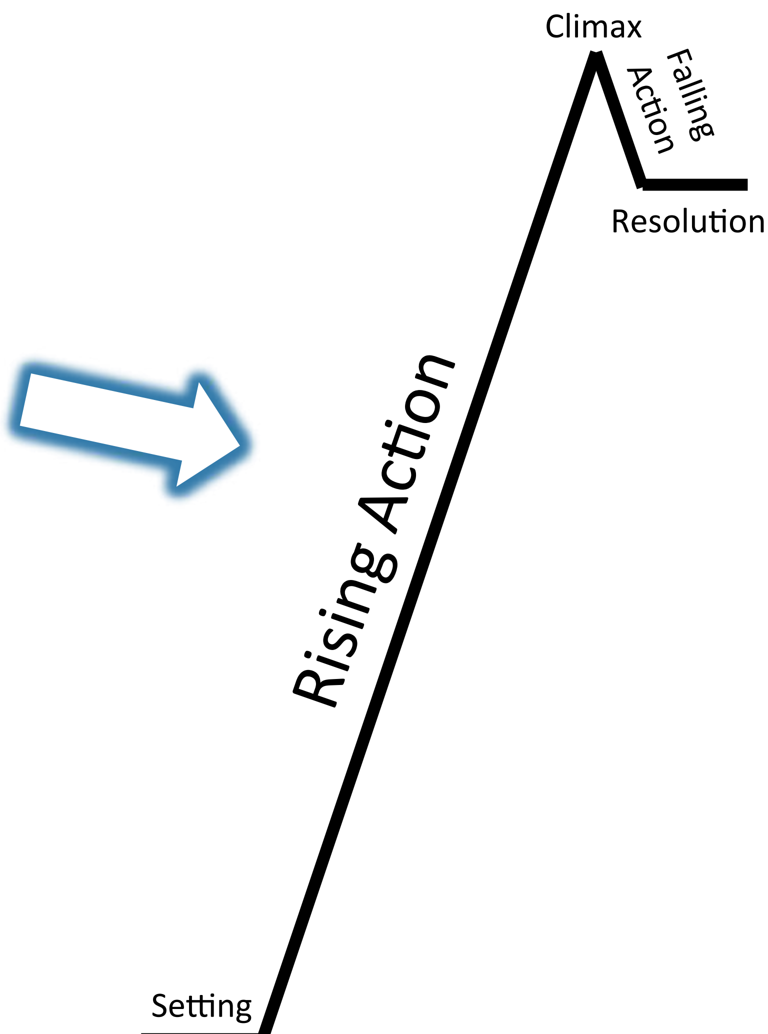
Oral Scientific Presentation

Tell a campfire story (like a caveman would).



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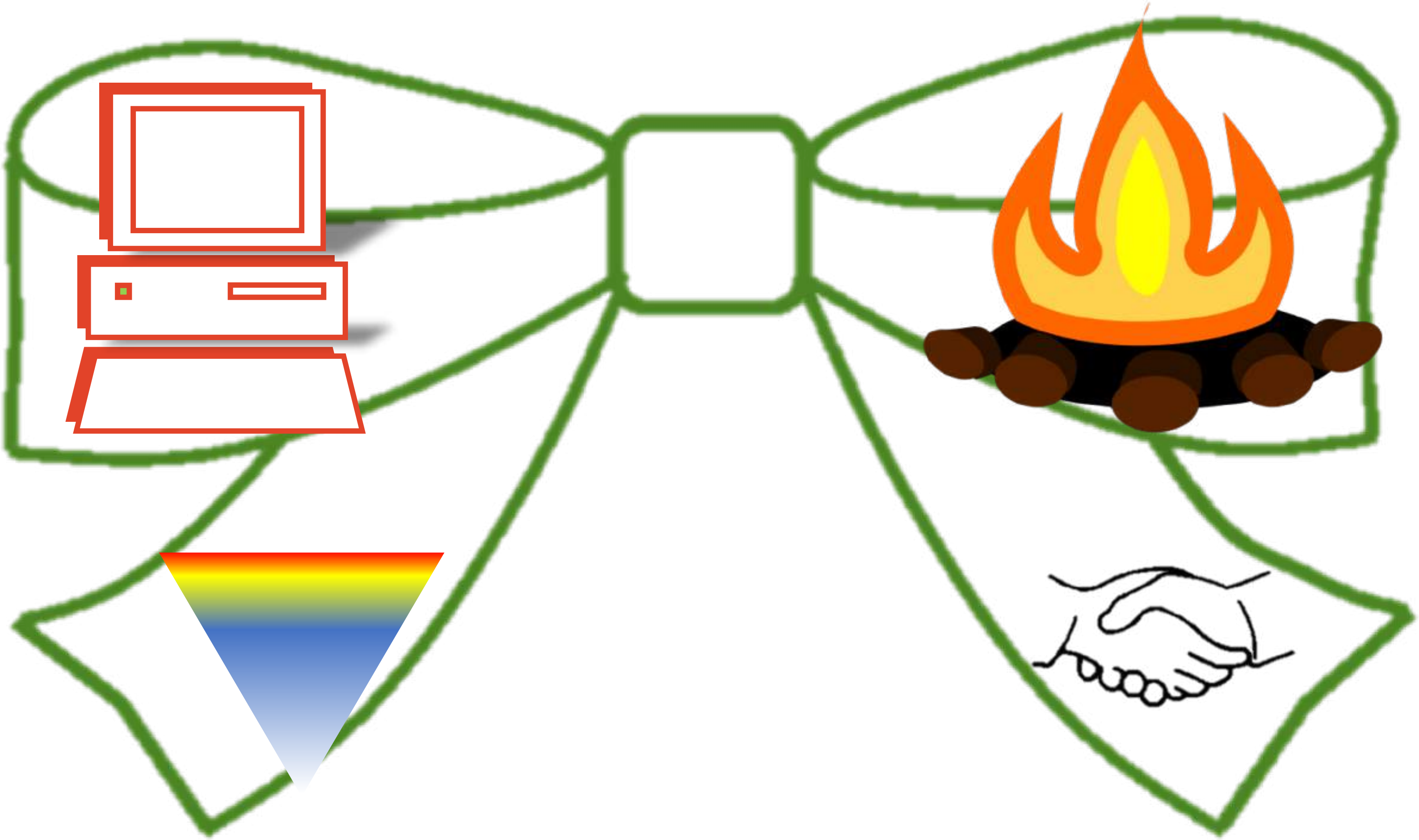
Public Relations



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