Is it possible to extend the Cahn-Ingold-Prelog priority rules to supramolecular structures and coordination compounds using lone pairs?

by José Elguero

In the Abstract of an article we published in *Chirality*, we wrote, "There are frequent situations in both supramolecular chemistry and crystallography that result in stereogenic centers whose absolute configuration needs to be specified. With this aim, we propose the inclusion of one simple additional rule to the Cahn-Ingold-Prelog (CIP) system of priority rules, stating that non-covalent interactions have a fictitious number between 0 and 1". [1]

Therefore, a system is needed to define them. Can the CIP system be used for non-covalent interactions and coordination compounds? [2] We think so, and propose this additional priority rule:

A coordinated lone pair has a fictitious atomic number between 0 and 1, i.e. larger than a lone pair (0) but smaller than a hydrogen atom (1). See Figure 1.

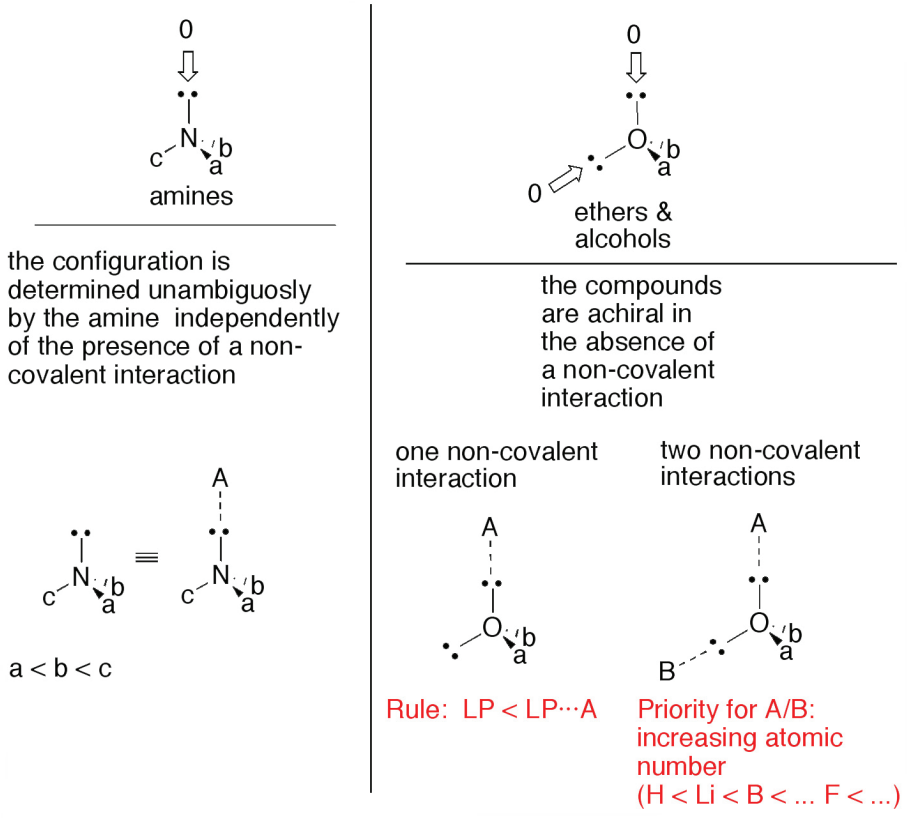


Fig. 1. Non-covalent coordination of lone pairs in amines, ethers and alcohols (note that protonated ethers are analogs of amines).

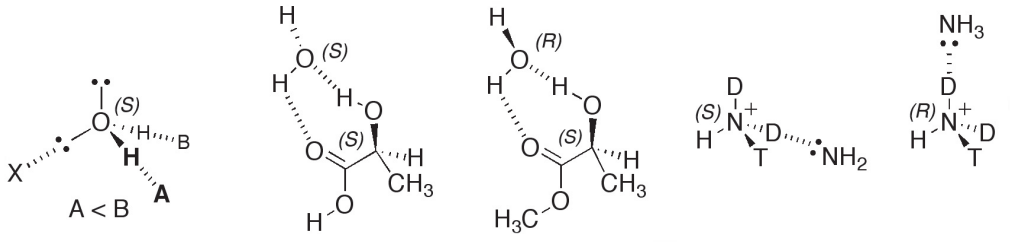
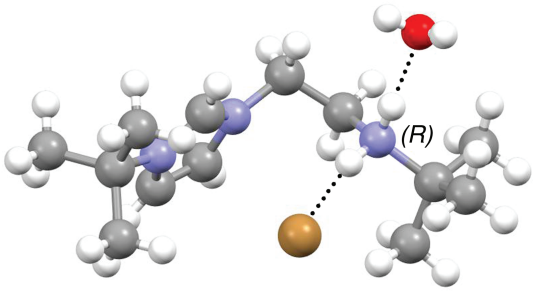
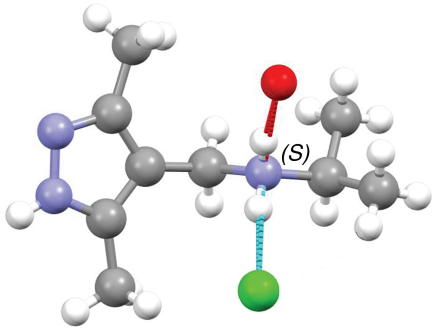


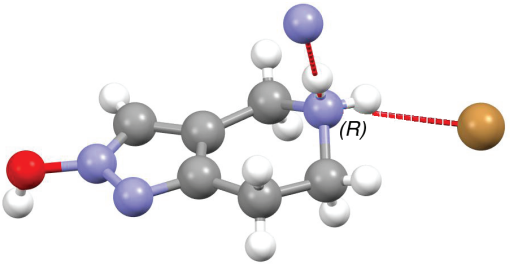
Figure 2. Hypothetical structures (on the right side the stereogenic center belongs to a cation)



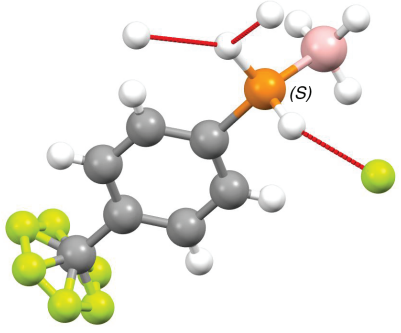
BEMDAZ *(R)*



CIKCUV *(S)*



FEZHOJ *(R)*



XARZIA *(S)*

Figure 3. X-Ray structures (ammonium and phosphonium salts) [3]

We have searched the literature for examples, and had no difficulty assigning those we found to the *R* or *S* enantiomer. So, we think it is possible, but is it useful? We think so, because there are very many possibilities. A few examples are shown in Figures 2 and 3.

Obviously, our proposal needs to be tested, criticized, and improved. We hope that it will reach chemists of all disciplines through *Chemistry International*, keeping alive the discussion about CIP rules! [4]

References

1. Alkorta, I.; Elguero, J.; Cintas, P. (2015) *Chirality* **27**:339–343.
2. The frontier between covalent and non-covalent interactions is fuzzy. For instance, in [F2H]– there is not a covalent and a hydrogen bond, but two identical bonds intermediate between covalent and HB. This happens for other HBs of the Low-Barrier nature (LBHB) [Rozas, I.; Alkorta, I.; Elguero, J. (2000) *J Am. Chem. Soc.* **122**:11154–11161] and for other non-covalent interactions, like, halogen bonds [Del Bene, J. E.; Alkorta, I.; Elguero, J. (2010) *J. Phys. Chem.* **114**:12958–12962].
3. Refcodes from the Cambridge Structural Database: CSD, version 5.35, updated May 2014. Allen, F. H. (2002) *Acta Crystallogr. Sect. B*, **58**:380–388.
4. See Blackburn, G. M.; Moss, G. P. How to Name Atoms in Phosphates, Polyphosphates and their Analogues, and Transition State Analogues for Enzyme-catalysed Phosphoryl Transfer Reactions, Provisional Recommedations; see www.iupac.org/project/2013-039-2-300; see, in particular, the Appendix "Procedure for use of Cahn-Ingold-Prelog rules for prochirality".

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