F. Nucleophilicity and Electrophilicity Scales

The kinetic methods developed in D were analogously employed to determine rate constants for the attack of carbocations and Michael acceptors at various C-nucleophiles (allylsilanes, allylstannanes, carbocyclic and heterocyclic arenes, enol ethers, enamines, enamides, diazoalkanes, metal-π-complexes, carbanions, isonitriles, ylides), hydride donors, halide and pseudohalide anions, N-nucleophiles (amines, pyridines, amide anions, azoles) as well as P-, O-, and S-nucleophiles. By defining benzhydrylium ions, quinone methides, and benzylidene malonates as reference electrophiles, which cover a reactivity range of more than 30 orders of magnitude, it has become possible to generate the most comprehensive nucleophilicity scale, presently available (reviews: # 124, 191, 219, 250, 262).

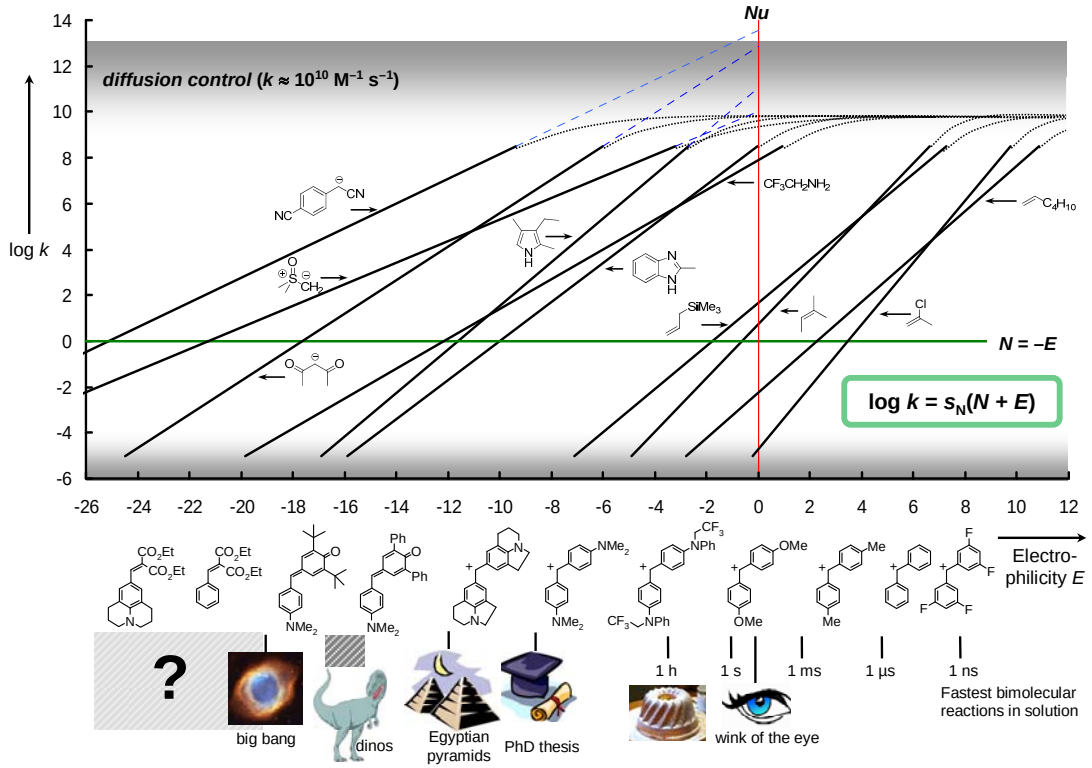

Figure 1. Rate constants for Electrophile-Nucleophile Combinations

It has been shown that equation 1, where electrophiles are characterized by one parameter (*E*) while nucleophiles are characterized by the solvent-dependent nucleophilicity parameter *N* and the nucleophile-specific sensitivity parameter s_N can be used to predict absolute rate constants with an accuracy of factor 10 – 100 in an overall reactivity range of 40 orders of magnitude.

$$\log k_{20°} = s_N (N + E) \qquad (1)$$

For qualitative analyses, the sensitivity factor s_N can be neglected, and as a rule of thumb one can expect electrophile-nucleophile combinations to take place at room

temperature if ($N + E$) > -5. Since diffusion limit is reached at $k = 10^9$ - 10^{10} $M^{-1}s^{-1}$, chemo-, regio- and stereoselectivity often break down when ($N + E$) > 10. As a consequence, most synthetically used reactions are found in the green corridor of Figure 2.

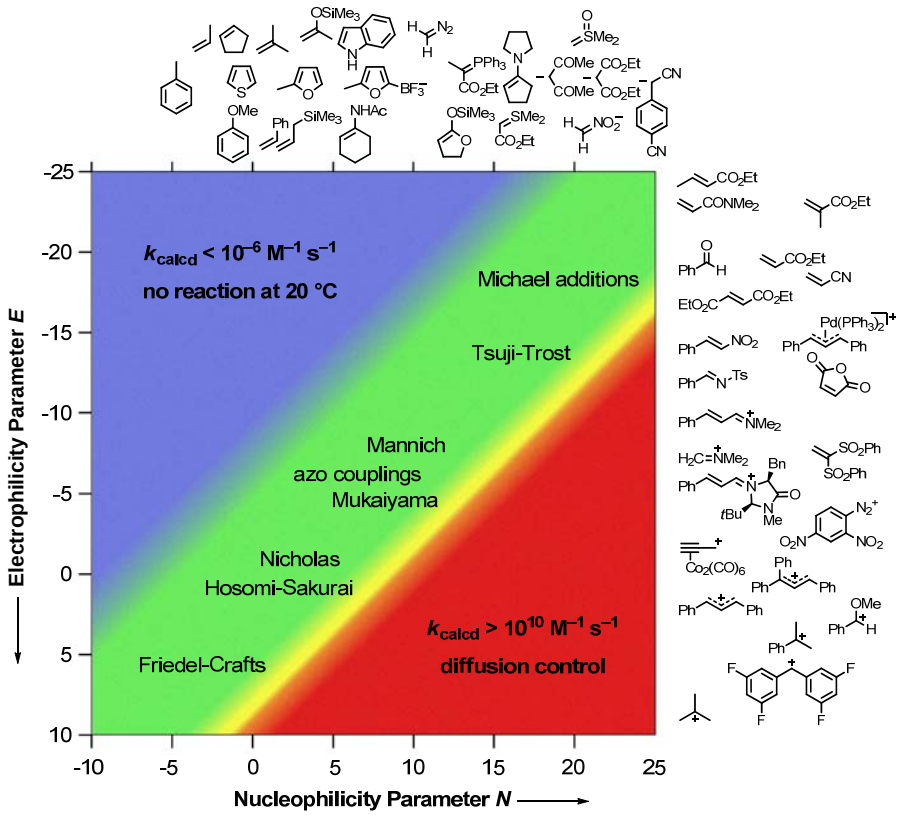

Figure 2. Where to find synthetically useful reactions

Open access to our database of electrophilicity and nucleophilicity parameters is provided at http://www.cup.lmu.de/oc/mayr/DBintro.html.

Poster presentations of our reactivity scales which can be used for synthesis planning can be downloaded (http://www.cup.lmu.de/oc/mayr/CDmayrPoster.html).