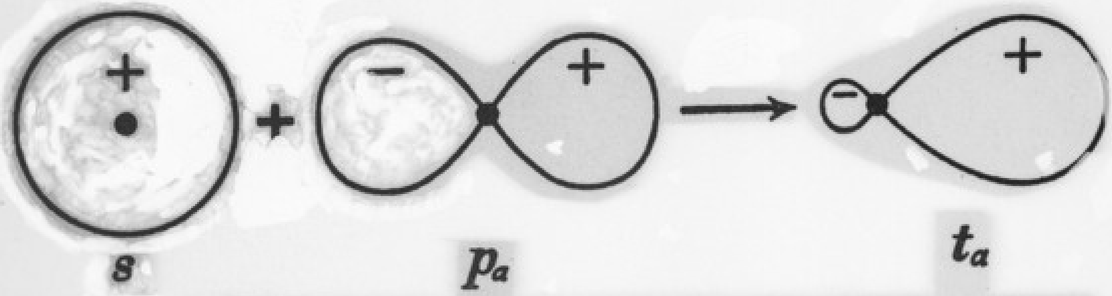
The same is true for b, c, and d. What could be more natural now than to suppose that instead of this partial pairing with all four carbon orbitals, there is complete pairing with some suitable combination of them? In this way we are led to the idea of hybridized orbitals as a means of preserving as far as possible the fundamental principle of perfect pairing.†



Boundary surfaces in the formation of an sp^3-hybrid atomic orbital.

The symmetry condition that we have introduced above shows that, so far as a is concerned, it is to be paired with the composite carbon orbital $s+x+y+z$. But the vector character of the p orbitals enables us to write

$$x+y+z = \sqrt{3}p_a,$$

where p_a is a $2p\sigma$ a.o. directed from the carbon atom at O towards the hydrogen a. Thus the appropriate hybrid is $s+\sqrt{3}p_a$. In normalized form this is $\frac{1}{2}(s+\sqrt{3}p_a)$. By symmetry the three other hybrids are $\frac{1}{2}(s+\sqrt{3}p_b)$, $\frac{1}{2}(s+\sqrt{3}p_c)$, $\frac{1}{2}(s+\sqrt{3}p_d)$. Let us call these $t_a,\ldots, t_d$ respectively. Then $t_a,\ldots, t_d$ are four composite a.o.'s directed in the four tetrahedral directions from the origin. We call this type of mixing the tetrahedral hybridization.