0.1 A Thermodynamic Topological Basis for the Bohr orbits.

The Pfaff Topological dimension of the 1-form of Action, A, can be put into correspondence with the four classic topological structures of thermodynamics: Equilibrium, Isolated, Closed, and Open systems. The classic interpretation is that the first two structures do not exchange mass (mole numbers) or radiation with their environment. The Closed structure can exchange radiation with its environment but not mass (mole numbers). The Open structure can exchange both mass and radiation with its environment. The following table summarizes these properties. For reference purposes, I have given the various elements of the Pfaff sequence specific names:

Topological p-form name	**PS** element	**Nulls**	**PTD**	Thermodynamic system
Action	A	$dA = 0$	1	**Equilibrium**
Vorticity	dA	$A\hat{}dA = 0$	2	**Isolated**
Torsion	$A\hat{}dA$	$dA\hat{}dA = 0$	3	**Closed**
Parity	$dA\hat{}dA$	$-$	4	**Open**

Table 1 Applications of the Pfaff Topological Dimension.

Intransitive accelerations There are two types of accelerations with fixed points: the accelerations that can be associated with rotations, and the accelerations that can be associated with expansions and contractions. An example of the latter is the inverse r squared acceleration associated with mass (gravity) and charge (Coulomb) attractions.

Suppose a thermodynamic domain can be encoded by a 1-form of Action that leads to a $1/\mathrm{r}^2$ attraction:

$$A_o = (mG/r)dt. \tag{1}$$

The Pfaff Topological dimension of A_o is 2, which would indicate that it is an isolated thermodynamic system, but not in true equilibrium. It is NOT a non-equilibrium thermodynamic system.

Now consider an addition to the Action to include rotational effects.

$$A_\omega = \{1/\lambda(x,y)\}(xdy - ydx) \tag{2}$$

The Pfaff topological dimension of A_ω is 2, unless $f(x,y)$ is a constant times a Holder norm: If

$$\lambda(x,y) = (ax^p + by^p)^{2/p} \tag{3}$$

the Pfaff topological dimension of A_ω is 1, as $dA_\omega = 0$, mod the singularities at the points where $\lambda(x, y) = 0$. Suppose that $p = 2$ so that the integral of A_ω over a closed path that excludes the singularities is zero. The value of the integral (to within a constant), by deRham's theorem, is quantized to the integers.

Without the integrating factor, $\lambda(x, y)$, the Pfaff topological dimension of A_ω, or A_o, is 2, but the Pfaff topological dimension of the sum, $(A_\omega + A_o) = A_{sum}$ is 4, as $dA_{sum}\hat{}dA_{sum} \neq 0$.

Hence the physical system that is composed of both fixed point accelerations of rotation (vorticity) $dA_\omega \neq 0$, and fixed point accelerations of expansion-contraction, $dA_o \neq 0$, is in general a dissipative non-equilibrium thermodynamic system.

If, however, the rotational term becomes closed, $dA_\omega = 0$, (that is, the angular momentum becomes quantized) then the combined system is reduced to a closed system of Pfaff Topological dimension 3.

Such Closed thermodynamic systems of PTD =3 are systems far from equilibrium, but can support "excited stationary" states that admit a Hamiltonian description. If the angular momentum is not quantized, then the system is a dissipative system far from equilibrium.

> If the rotation acceleration (angular momentum) is topologically quantized, the electrons are in Pfaff Topological Dimension 3 "excited stationary" states, far from equilibrium, but with a non-dissipative Hamiltonian dynamics (which can exist in thermodynamic states of odd Pfaff dimension – contact manifolds).
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> If the rotation acceleration was not topologically quantized, the thermodynamic system would be in a Pfaff Topological Dimension 4 state which supports irreversible dissipative (but not Hamiltonian extremal) processes and fluctuations. Extremal Hamiltonian dynamics cannot exist in a thermodynamic state of even Pfaff dimension (a symplectic manifold).