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The Structures and Thermodynamics in (Paracrystalline) Polymorphism of Liquid Water

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This paper starts by detailing the extraordinary omission in thermodynamics and the phase rule, taught and used by most scientists for a century, which ignored all vector and tensor intensive variables beyond the scalar 'p' and 't'.

It then treats the parallelism between the two most abundant phases on the earth's surface: liquid H₂O and crystalline SiO₂. A parallelism slowly being accepted for their polymorphism in the many stable, and an almost infinite number of metastable, phase transitions. These are established for SiO₂—as will be shown—and slowly being accepted for liquid water. The term 'paracrystalline' is introduced, to replace the misleading use of the term clusters. The latter refers only to one part of the short range—and ignores the long range arrangements which exist in the liquid water phase.

This background is necessary to understand the evolution of the science of polymorphism, first in the liquid state generally, and then specifically in liquid H₂O. The data summarized by Chaplin and Stanley establish the real and putative existence of some dozens of polymorphs, but these are limited to the case where the intensive variables are only pressure and temperature. To these we must now add the enormous range of structural changes we have been able to effect in our laboratory by the use of polarized electric and magnetic fields and acoustic radiation as normal, albeit vector and scalar intensive variables. In addition, we have also demonstrated the role of the related phenomenon of epitaxy (at least) on various liquid structures which clearly change the p and t conditions for stability of a phase.

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