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# Initiating *Tresino* Phase-Transitions in Laboratory Hydrogen-Plasmas

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## Article Info

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## Abstract

This paper introduces a recently-recognized hydrogen-plasma energy release process and examines ways to initiate the process in laboratory-based hydrogen-plasmas. In addition, the process has possible implications in present hydrogen-plasma experiments showing the importance of *tresino* physics.

**Keywords:** *Tresinos*, coronal mass ejections

## Introduction

In the early decades of last century, much was learned about atomic physics and quantum mechanics from telescopic observations of the Sun [1]. In the 1930s, Hans Bethe and his colleagues [2] determined that nuclear reactions under the enormous pressures in the solar core were responsible for the energy production in the Sun. Moreover, the reactions were determined to be a group of fusion interactions. Importantly, these new understandings later gave rise to a number of designs for *fusion-power reactors* that were hoped to be the successors to fission reactors. Unfortunately, attempts to show that *fusion reactors* represented a viable power system have not yet been demonstrated but they continue under development around the world.

However, there is another aspect of solar observations that have yet to be fully understood; specifically, the gigantic explosions often referred to as "coronal mass ejections" or CMEs. These very large explosive events cannot be *fusion reactions* like those in the solar-core because they originate at plasma densities much too low compared to those of the core. Nonetheless, the observations are important because they appear to be a fundamental source of hydrogen-plasma energy generation, the focus of my recent CME research.

## *Tresino* Physics

Readers unfamiliar with *tresinos* will benefit from reading the *Introduction* section in my paper on "Hidden Baryons" [3], as *tresinos* are crucially important to understanding how the hydrogen-plasma energy source obtains. This paper includes a basic (classical) derivation of the *tresino* composite system. After becoming comfortable with what *tresinos* are, it might be further useful to understand their impact in geophysics [4] and cosmology [5], before I discuss their importance in the Sun. Many of the papers co-written with my late colleague (John R. Reitz) and me over the past years about *tresino-physics*, can be found in the just-cited references.

## The *Tresino* Phase-Transition in the Sun

As John and I concluded in our "Early Universe" paper [5], it was important to determine if there was a location in the Sun that supported the *tresino* phase-transition. In my recent paper [6], I found that indeed there was such a location at a somewhat *surprising* depth of only 2350 km below the solar surface. This location was found between lines $n = 26$ through $n = 29$ of Avrett & Loeser's Model C7 of the *quiet* Sun. The average plasma densities and temperatures from these data were found in [7], to be:

$$n_e = 1.6 \quad 10^9/\text{cm}^3 \text{ and } T = 17.5 \text{ eV.}$$

These parameters represent the conditions expected to produce the energy release in laboratory hydrogen-plasmas as well. I note here, also from [7], that a one $\text{cm}^3$ sample at the phase-transition conditions would yield about 5.9 MeV to the local environment; with, of course, a smaller energy-release expected from smaller samples.

In addition, this latest paper [7] focussed on the microphysics of how the *tresino* phase-transition actually takes place. Interestingly, Debye spheres play an important role in how this happens. Note that Debye spheres insulate centrally-located protons from the surrounding electrons in an electrostatic-equilibrium. When the Debye spheres are *destabilized*, a "flood" of electrons flows into the vicinity of the protons; after which protons may capture two electrons converting them into *tresinos*. When this happens, the *tresinos* "binding energy" is released into the local plasma environment.

## *Tresino* Phase-Transitions in Laboratory Plasmas

It is expected that laboratory-experiments observing the *tresino* phase-transition will generally be of two types: Those by design and those by "accident". In the first case, there can be many possibilities depending upon a laboratory's source of energy deposition. One such example is presented in Figure 1 below where a laser-heating pulse is focussed into the throat of a pinhole aperture through which hydrogen gas has been allowed to flow into a vacuum chamber. The laser wave-length and pulse-length will have to be adjusted along with the gas flow rate to achieve access to the *tresino* phase-transition temperature and the phase-transition density. When successful, the phase-transition releases the *tresinos* "binding energy" as streams of *tresinos* and protons and their associated magnetic fields. Among other detection methods, the exhaust streams can be monitored by pick-up coils surrounding the exiting "plume". In the second case, the phase-transition by "accident", it is possible that the *tresino* phase-transition has already been "accidentally" encountered in laboratory hydrogen-plasmas but has not been recognized as such, except that some *extra* energy may have been observed.

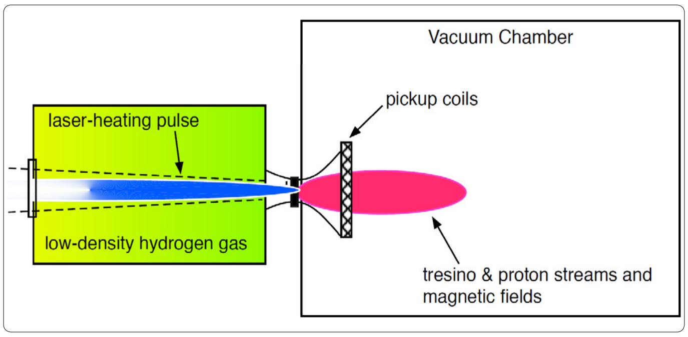

**Figure 1.** A laser-heating pulse is focused into the throat of a pinhole with hydrogen gas

This is perhaps most likely and may have happened in plasma-pinches such as *plasma focus* devices [8], small Z-pinches [9], and/or large Z-pinches [10]. In some experiments, deuterium gas may have been used, in which case *deuteron-tresinos* would have been created, which in turn would have allowed them to undergo *d*-d* nuclear reactions (where *d** represents a *deuteron-tresino*). Such *tresino*-driven nuclear reactions have already been discussed in [11] where the electron screening of the *deuteron-tresino* plays a significant role in enhancing the reaction rate of the otherwise well-known *d-d* nuclear reactions due to the substantially-reduced Coulomb barrier repulsion.

Finally, another example of "accidental" *tresino* formation might occur in a force-balanced plasma configuration (e.g., tokamaks) wherein a *tresino* phase-transition zone forms (accidentally) producing excess energy but also disrupting the force-balance, clearly a net-negative result in such an experiment.

## Final Remarks

Experiments that access the *tresino* phase-transition in a laboratory hydrogen-based plasma are important because they could confirm the nature of CMEs on the Sun and could also provide additional basic plasma-physics understanding. Variations of the nuclear reactions noted above might also yield benefits in the development of fusion reactors. For example, if a design of an experiment can be found that maintains the phase-transition plasma conditions for an extended time, it could offer a new method for producing a large-scale hydrogen-energy system either with or without nuclear reactions.

Accessing the *tresino* phase-transition could also provide an approach to initiating *tresino*-driven nuclear reactions such as $^{6}Li(d^*, p)^{7}Li+5$ MeV and $^{11}B(p^*, \alpha\ \alpha)\alpha+8.7$ MeV. These reactions may be accelerated due to the previously-mentioned *tresino* interactions having lowered the Coulomb-barrier as discussed in [11]. Finally, experiments using gas mixtures, e.g., deuterium and tritium, might also be useful in some special situations in ongoing fusion programs. It is my hope that laboratory experiments like these can be fielded in the near future and are found to be successful.

# Dedication

I dedicate this paper to my late mentor, collaborator, and friend, Dr. John R. Reitz, without whose efforts, this work would not have been possible.

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