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Posted Date: 4 March 2026

doi: 10.20944/preprints202603.0328.v1

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Article

Dynamic Thermal Management and Tunable Magnetic Phase Transitions via a Dynamic Chiral Thomson Effect on Rotating Conductors

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Abstract

In this work we will illustrate a new wavelike non linear heat conduction model aimed to implement chiral thermal management and dynamic tunable chiral thermal emission on rotating conductors exposed to chopped laser beam. We will assume the existence of a rotational thermal Hall effect due to a self-induced out of equilibrium Barnett magnetic field showing that they it allows to deviate transversally the harmonic heat flux and to modulate the phase velocity of helical thermal waves propagating on the rotating metallic disks. We deduce a new dynamic chiral Thomson effect proportional to the angular velocity vector of the disk, giving an estimate of its Thomson coefficient in the case of an iron sample. We show that the laser induced chiral Thomson electric field and the time dependent Barnett magnetic field can be exploited to enhance and dynamic control magnetic phase transitions. We introduce finally a dynamic tunable chiral thermal emissivity dependent on a gauge breaking thermal Poynting vector outlining its relevance for a novel rotational approach to non-reciprocal photonics.

Keywords: dynamic chiral thermal management; dynamic chiral Thomson effect; dynamic tunable magnetic phase transitions; dynamic tunable chiral thermal emissivity

1. Introduction

In the last ten years the search of new more efficient spintronic devices has stimulated some authors to investigate electric field induced orbital angular momentum in metals, that is a new research issue still at early stage of non-equilibrium orbital physics called orbitronics [1]. One important research direction that has been exploring very recently is how to convert orbital currents to charge currents to enhance spin Seebeck effect and improve thermoelectric performances. This new research issue of orbital physics, although lacking at the moment a solid experimental verification of the predicted orbital currents, might explain new phenomena such as orbital Hall effect and anomalous Hall effect in ferromagnets and semimetals [1]. These studies have not concerned till now investigations on the effect of out of equilibrium orbital currents on enhancing efficiency of junction less thermoelectric devices which, conventionally, exploits the classical stationary Thomson effect or its phase transitions induced enhancement [2–7]. Our work on the contrary is aimed to develop an out of equilibrium generalization of Thomson effect on rotating metals and semimetals caused by thermal waves propagating on moving samples [8,9] which might be applied to dynamic control of thermoelectric devices performances via a self-induced rotational thermal Hall effect. The principal motivation that inspired our proposal is to elaborate a new unified framework of heat diffusion and thermal emission based on orbital physics which might implement chiral thermal management and tunable magnetic phase transitions via a dynamical chiral Thomson effect.

In fact, although it is an old thermoelectric phenomenon discovered by Thomson in 1850, has attracted recently a lot of renewed interest due to the observation of giant Thomson coefficient during magnetic phase transitions which allowed to improve thermal efficiencies of conventional junction

less thermoelectric devices. Our work, although based on a theoretical model, is aimed to develop a novel dynamic rotational approach to thermoelectricity and thermal emission predicts a new generalized dynamic chiral rotational Thomson which might be exploited for technological applications, whenever confirmed experimentally.

In fact, the main result of our model is the prediction of a generalized dynamic rotation induced Thomson cooling-heating effect, in accordance with recent experiments confirming the existence of magneto Thomson effect and of transverse Thomson effect [10,11], due to an out of equilibrium dependent Barnett magnetic field applied orthogonally to either the temperature gradient and to the Thomson electric current. We will show that harmonic heat source due to a chopped laser beam induces a dynamic enhancement of the Thomson coefficient, giving an estimate on iron samples. Finally, we deduce the existence of a chiral tunable thermal emissivity, discussing its relevance for future non linear approach to thermal harvesting, polarized control of thermal radiation and non reciprocal photonics [12–14] on rotating conductors.

2. Dynamic chiral Thermal Management

We will assume that the harmonic heat source due to chopped laser beam on the rotating disk induce an effective temperature dependent Barnett magnetic field $\vec{B}(T)$ parallel to the angular velocity vector of the body $\vec{\Omega}$ [15,16], that is an out of equilibrium photomagnetic effect

$$(1) \vec{B}(T) = \frac{\vec{\Omega}}{g(T)} = \frac{2m(T)}{e} \vec{\Omega} = b(T)\vec{\Omega},$$

with $b(T)=2m(T)/e$ a new coefficient inverse to the gyromagnetic ratio $g(T)$, e the electron charge and $m(T)$ a new unknown thermal field dependent effective electron mass $m(T)$.

We will introduce, in accordance with similar approach used to study performance of thermoelectric devices, an empirical coefficient A defined as a temperature average of the Righi-Leduc number $A(T)$

$$(2) A = \int_{T_0}^{T_c} \frac{A(T)dT}{T_c - T_0} = k A_{R-L} = k \int_{T_0}^{T_c} \frac{A(T)dT}{T_c - T_0} = k \int_{T_0}^{T_c} \frac{\frac{\nabla_y T}{B \nabla_x T} dT}{T_c - T_0},$$

with

$$(3) A_{R-L}(T) = \frac{\nabla_y T}{B \nabla_x T} = \frac{\partial_y T}{B \partial_x T},$$

so that the equation (1) can be rewritten as

$$(4) \vec{B}(T) = \frac{2m(T)A\vec{\Omega}}{e} = \frac{b(T)\vec{\Omega}}{A}.$$

It can be deduced using the classical Drude theory of electron conduction on metals that this coefficient A , associated to Righi-Leduc transverse heat flux, is proportional to the Hall coefficient $R_H = 1/ne$ and to the electron relaxation and the electron relaxation time τ_0 by the relation [9]

$$(5) A = \sigma R_H = \frac{\tau_0 e^2 n}{m_{eff}} R_H,$$

with A the average coefficient of (2) dependent on the metal sample considered and was originally measured on bismuth.

Our proposal aims to outline importance of chiral wavelike thermal properties in rotating frames generalizing a similar approach published recently on quantized heat transport and gauge symmetry [17]. It is based on the introduction of a transverse gauge breaking heat flux current vector due to a self-induced nonlinear rotational thermal Hall effect generated on rotating disks by a chopped laser beam based on [9], caused by the effective Barnett magnetic field of (1)

$$(6) \vec{q}(t + \tau) = -k \nabla T + b(T) \vec{\Omega} \times \nabla T$$

with τ a local electron relaxation time of the rotating conductor to be determined and k the standard thermal conductivity of the conductor at rest.

This new wavelike heat diffusion model is a chiral nonlinear generalization of Cattaneo-Vernotte model [18,19], since the transverse heat flux added at second member of (6) is proportional via the function $b(T)$ to the angular velocity $\vec{\Omega}$ vector of the rotating disk. We will show that (6) implements a dynamic chiral thermal management since the effective out of equilibrium Barnett magnetic field

of (1) allows to control the direction of heat flux by tuning the shifted pulsation of the thermal field T due to a thermal rotational Doppler effect.

We remark that differently from conventional analysis of the thermal Hall effect the deflection angle of transverse heat flux is a dynamic deflection angle dependent on the thermal field T that, in polar coordinates [9], is given by

$$(7) \quad \theta_{R-L}(T, \Omega) = \text{Re} \frac{k_{\theta}(T) \nabla_{\theta} T}{k_r(T) \nabla_r T},$$

with at second member the real part of the complex valued functions, and with the polar and azimuthal gradients given by

$$(8) \quad \nabla_r T = \frac{dT}{dr}; \quad \nabla_{\theta} T = \frac{dT}{r d\theta}$$

We will assume in the following a frequency shift due to a rotational Doppler effect of the thermal field due T to a thermal analogue of the Zel'dovich effect [20,21].

$$(9) \quad \frac{dT}{dt} = D_t T = -i\omega' T,$$

with the shifted pulsation

$$(10) \quad \omega' = \omega - m\Omega$$

and m the topological index of the structured thermal field T , associated to angular momentum transfer, whose chirality depends on the sign of this integer number. We note that the time derivative of (8) is a convective time derivative comoving with the rotating disk

$$(11) \quad D_t = \frac{\partial}{\partial t} + \Omega \cdot \frac{\partial}{\partial \theta}$$

Therefore using (9) and (10) it is possible to introduce a thermal Hall angular velocity $\Omega_{R-L}(T, \Omega)$ proportional to this shifted pulsation ω'

$$(12) \quad \Omega_{R-L}(T, \Omega) = \frac{d\theta_{R-H}(T, \Omega)}{dt},$$

with

$$(13) \quad \frac{d\theta_{R-H}(T, \Omega)}{dt} = \text{Re} \frac{d\theta_{R-H}(T, \Omega)}{dT} \frac{dT}{dt} = \frac{d\theta_{R-H}(T, \Omega)}{dT} \omega' \text{Re}(iT),$$

which change sign when the shifted pulsation ω' does and is zero if it is satisfied the resonant condition of Zel'dovich rotational superradiance

$\omega' = 0$, that is if

$$(14) \quad \omega = m\Omega.$$

We note that this rotation induced chiral thermal control can be tuned changing the angular velocity Ω of the disk is associated, as we will see in the next paragraph, to peaks of the Thomson coefficient and to symmetry breaking chiral magnetic phase transitions.

In fact, it is possible to show [9] that the new thermal fields T satisfy, far from the focus of the laser beam incident on an ultrathin disk, a homogeneous generalized telegraphist wave equation, that using the convective time derivative of (9) can be written as

$$(15) \quad D_t^2 T + \frac{D_t T}{\tau(r, \omega')} - v_T^2 \nabla^2 T = 0$$

We will find the local relaxation time $\tau(r, \omega')$ looking for particular solutions temporally periodic and spatially attenuated (SATP solutions) given in polar coordinates (r, θ) by

$$(16) \quad T(r, \theta, t) = T_0 e^{i[\beta(r)r + m\theta - \omega't]}$$

with T_0 the average environment temperature and $\beta(r)$ a local complex valued wave vector whose real part is a solution of the differential equation in the r variable

$$(17) \quad \text{Re} \frac{d(\beta(r)r)}{dr} = \frac{R\omega'}{rv_T} - \frac{\gamma\omega'r}{2k},$$

with k the thermal conductivity and γ the specific heat at constant pressure of the disk at rest.

We note that this new structured thermal fields have, differently from conventional one local tunable phase velocity v_T given by

$$(18) \quad v'_T = \sqrt{\frac{k}{\gamma\tau(r, \omega')}} = \frac{v_T}{n(r, \omega')},$$

with the phase velocity at rest v_T on the border of the disk and the effective index of refraction of thermal waves defined respectively $n(r, \omega')$ as

$$(19) \quad v_T = \frac{2k}{\gamma R}$$

and

$$(20) \tau(r, \omega') = n^2 \tau_0.$$

Taking in account (19) it is possible to write, once resolved the simple differential equation (19), the local electron relaxation time $\tau(r, \omega')$ as

$$(21) \tau(r, \omega') = \frac{k}{\gamma \omega'^2} \left[\omega'^2 \left(\frac{R}{rv_T} - \frac{\gamma}{2k} r \right)^2 + \frac{m^2}{r^2} \right]$$

We note that the tunable thermal phase velocity of (16) becomes linear dependent on the rotational Doppler frequency shift ω' on the border of the disk

$$(22) v'_T(R) = \frac{R\omega'}{m} = \frac{R(\omega - m\Omega)}{m},$$

which, going to zero when $\omega' = 0$, can be exploited to prove existence of thermal rotational super radiant effect by measuring heat transport arrest on the border of the disk.

In fact, the thermal wave phase velocity (16), depending on the local relaxation time $\tau(r, \omega')$, depending on the effective local thermal refractive index n , makes the disk an effective dispersive medium in a similar way to what has recently been proposed in a study on the hyperbolic propagation of heat on metamaterials [22].

It is possible to show [9] that the nonlinear telegraphist equation with particular solutions (16), singular at the center of the disk, have chiral isothermal helical wavefront profiles

$$(23) \theta(r) = \frac{R\omega'}{mv_T} \ln \frac{r}{R} - \frac{\gamma\omega'}{4km} r^2,$$

with R the disk radius and v_T the phase velocity of the conductor at rest and with m associated to the angular momentum of the polarized laser beam and transported by the helical thermal wave considered.

It is possible to test experimentally the rotation induced thermal control predicted by our model introducing a new parameter given by the difference between the angle of the isothermal profile on the border R of thin rotating disks and those one of identical disks at rest given by

$$(24) \Delta\theta(R, \Omega) = \frac{\gamma R^2 \Omega}{4k}.$$

For example, assuming that the rotating disk is iron, inserting the values of its thermal conductivity and specific heat and choosing angular velocity $\Omega=100\text{Hz}$ and $R=1\text{dm}$, from (19) we have an estimate of the detectable relative angle of deviation induced by rotation given by

$$(25) \Delta\theta \cong \frac{45000}{320} 10^{-2} \cong \frac{4.5}{320} \cong 1.4\text{rad}$$

This theoretical prediction could be easily tested in laboratories by using IR thermal cameras with lock in thermography technique to map isothermal profiles of the helical thermal waves and, whenever confirmed, could pave the way to dynamic chiral thermal management.

On the contrary to compare the isothermal angle deviation respectively when the laser is switched on and when it is switched off it can be used on the border of the disk the following quadratic relation in R

$$(26) \Delta\theta(R, \omega' = \Omega) = \frac{\gamma[(1+m)\Omega - \omega]}{4k} R^2,$$

which, when the thermal wave has m equal to zero becomes the simple relation

$$(27) \Delta\theta(R, \omega' = \Omega) = \frac{\gamma(\Omega - \omega)}{4k} R^2.$$

We will see in the next paragraph that this rotational induced chiral control of heat transport can be exploited to enhance magnetic phase transitions via a self induced dynamic chiral Thomson effect.

3. Dynamic chiral Thomson Effect and Tunable Magnetic Phase Transitions

We will show now that the Barnett magnetic field self-induced by rotation $B(T, \Omega)$ of (1), will generate a dynamic Thomson voltage $\Delta V(T, \Omega)$ [9], whose radial pulsating electric field that will tends to counteract the dissipative heating process due to the Joule effect.

In fact, according to Faraday's law, a temperature dependent electromotive force is induced on the rotating disk $\Delta V(T, \Omega)$ proportional to the angular velocity Ω of the rotating conductor

$$(28) \Delta V(T, \Omega) = - \int_0^r \frac{dB_{eff}}{dt} 2\pi r dr = - \int_0^r \frac{dB_{eff}}{dT} \frac{dT}{dt} 2\pi r dr,$$

which by using the Zel'dovich condition (9) and the function $b(T)$ introduced in (4), it can be shown to be proportional to the angular velocity of the rotating disk Ω

$$(29) \Delta V(T, \Omega) = i \frac{\omega' \Omega}{A} \int_0^r \frac{db(T)}{dT} T 2\pi r dr.$$

This dynamic Thomson voltage is associated to an oscillating conservative radial Thomson electric field $\vec{E}$ tuned by Ω with radial component given by

$$(30) E_r(T, \Omega) = -\nabla \Delta V(T, \Omega) = -\frac{d\Delta V(T, \Omega)}{dr} = i 2\pi r \frac{\omega' \Omega}{e} \frac{dm(T)}{dT} T.$$

We note that this new dynamic chiral Thomson cooling-heating effect might be used as signature of magneto thermal phase transitions since the radial component of the Thomson electric field E changes electron conduction bands, pushing electrons harmonically outward and inward, in accordance with an out of equilibrium generalization of the Stewart-Tolman effect recently investigated for its relevance in out of equilibrium thermodynamics of neutron stars [23–25].

The new oscillating thermoelectric field can be associated to an out of equilibrium thermodynamic process with specific entropy production in a rotating frame which generalizes the conventional one on sample at rest [7]

$$(31) \partial_t s(T, \Omega) = Re \frac{div \vec{q}}{T}$$

$$(32) D_t s(T, \Omega) = Re \left(\frac{\vec{q}^2 T}{\sigma} + k(\nabla T^2) - i\omega' \gamma T \right),$$

with σ the electric conductivity.

We note that our model, differently from a similar wavelike nonlinear heat diffusion model recently investigated [26], depends on the dynamic chiral Thomson effect previously discussed by

$$(33) \vec{q}(t + \tau) = S(T) T \vec{j} - k \nabla T$$

with $S(T)$ a dynamic generalization of the magneto Seebeck coefficient recently investigated [27].

From (6) we deduce

$$(34) S(T) T \vec{j} = A \left[\vec{B}(T, \vec{\Omega}) \times \nabla T \right] = b(T) \vec{\Omega} \times \nabla T$$

with the orbital electric current density $\vec{j}$ given by

$$(35) \vec{j} = \sigma (\vec{E} - S \nabla T).$$

We note that the specific entropy production of (31) can be negative whenever the gradient term due to the Thomson effect is bigger than the first term due to the Joule effect. Moreover equation (31) can be exploited to tune dynamically magnetic phase transitions, assuming that they are associated to maxima or minima of the entropy flux rate comoving with the rotating disks, that is

$$(36) D_t s(T, \Omega) = \frac{\partial}{\partial t} s(T, \Omega) + \Omega \cdot \frac{\partial}{\partial \theta} s(T, \Omega) = 0,$$

using the time convective derivative D_t solidal to the rotating disks of (11).

From (35) we can generalize the stationary local conservation law of energy density and the conventional specific entropy flux rate of a system at rest [7], taking in account that it depends on helical thermal fields solutions of telegraphist equation introduced in (16)

$$(37) D_t s = \frac{\vec{E} \cdot \vec{j}}{T} - \frac{div \vec{q}}{T} = \frac{\vec{j}^2}{\sigma T} + k \frac{(\nabla T)^2}{T^2} = \gamma D_t T = -i\gamma \omega' T,$$

by (31) and (35) it follows that the electric current density on the thermal field T satisfies the relation

$$(38) \vec{j}^2 = -\sigma (k \nabla \ln T^2 + i\gamma \omega' T).$$

This equation allows to deduce the explicit dependence on the thermal field T of the magneto Seebeck coefficient $S(T)$, once is known by experiments for a specific metallic sample the effective electron mass $m(T)$ introduced in (1), and inserting in the equation (33).

As a case study of the rotation induced thermoelectric effect associated to magnetic phase transitions we illustrate some simple estimates of the average dynamic Thomson voltage $\Delta V(T, \Omega)$ of (28) in the simple case of ferromagnetic disks. We will assume a generalized Curie-Weiss like magnetization law of the out of equilibrium Barnett magnetic field of (1),

$$(39) Re B(T, \Omega) = Re \frac{\chi'}{T} = \frac{\chi}{T_0(1 - \cos \omega' t)} \cong \frac{2\chi}{T_0(\omega' \tau_{laser})^2},$$

with $\tau_{laser} \cong 10^{-9} - 10^{-12} s$ the average laser pulse duration, with the local magnetic susceptibility χ' linear dependent on the shifted pulsation ω' of the thermal field T .

Inserting this relation in (28) we deduce the oscillating self induced chiral Thomson voltage,

$$(40) \Delta V(T, \Omega) \cong -i\omega' \int_0^r \frac{\chi}{T} (1 + \tau_0 \omega') 2\pi r dr = \frac{i\pi \omega' \chi (1 + \tau_0 \omega') r^2}{T},$$

becoming on the border a detectable minimum of the oscillating electric voltage given by

$$(41) \operatorname{Re} \Delta V(T_0, \Omega) \cong \frac{i\pi\omega'\chi(1+\tau_0\omega')R^2}{T_0(1-\cos\omega't)} \geq 0,1 \text{ mV},$$

taking $R=0,1\text{m}$, $\chi = 10^6$ and $T_0 = 300\text{K}$.

We note that assuming an average magneto Seebeck coefficient of iron disk at rest $S_0 \cong 1,9 \times 10^{-5} \text{V/K}$ we can estimate the minimum average fluctuation of the Curie temperature $T_c \cong 1043\text{K}$ on the border of the disk of radius $R=0,1\text{m}$ to be given by

$$(42) \Delta T_c \cong \frac{1 \times 10^{-4}}{1,9 \times 10^{-5}} \geq \frac{10}{1,9} \cong 5,2\text{K}$$

This not negligible effect shows that rotation and harmonic heat source of a laser beam with chopper can induce tunable magnetic phase transitions. Therefore, our new predicted Curie temperature fluctuations could be easily detected in Laboratories with modern infrared thermocamera lock in technique, proving the existence of dynamic chiral management and magnetic phase transitions associated to peaks of the average rotation induced chiral Thomson effect.

We note that the laser induced out of equilibrium thermodynamics on rotating metallic disks implies, taking in account the dynamic chiral Thomson effect, the following generalization of the Faraday law on the rotating metallic disk given by

$$(43) \operatorname{rot}(\vec{E} - S(T)\nabla T) = -D_t \vec{B}(T),$$

with $\vec{B}(T)$ the out of equilibrium Barnett magnetic field of (1). This equation implies that there is a new dynamic transverse Thomson electric field with non-null rotor given by

$$(44) \operatorname{rot} S(T)\nabla T = \frac{d}{dt} \vec{B}(T) \frac{dT}{dt} = i\omega'T \frac{d}{dt} \vec{B}(T)$$

proving the existence of a dynamic transverse magneto Thomson effect, generalizing recently observed magneto and transverse Thomson effects [10,11], whenever the shifted pulsation ω' is non zero.

We remark that the predicted dynamic chiral magneto Thomson effect allows to deduce, once solved equation (43) the magneto Seebeck coefficient $S(T)$, allows to deduce the thermal field dependence of the Thomson coefficient [7],

$$(45) \tau_{TH}(T) = T \frac{dS(T)}{dT}$$

Therefore, is it possible to compare the figure of merit of new rotating thermoelectric devices with respect to conventional ones at rest using the relation

$$(46) ZT = \frac{\sigma S(T, \Omega)^2}{k} = \frac{L_0 S(T, \Omega)^2}{k^2 T},$$

with L_0 the Lorenz number, having assumed the Weidemann-Franz law for rotating metallic disks. Due to the rotational super radiant effect it is possible to have giant Thomson effect, enhancing the oscillating electric field of (30) and reducing the relative magnitude of the Joule heating process, by tuning the thermal field pulsation ω' .

For example, in the case of iron disk using the chiral Thomson voltage of (40) and (41) we get the following naïve estimate

$$(47) \operatorname{Re} \tau_{TH}(T_0) \cong -\frac{2\pi\omega'\chi R^2}{T_0^2(1-\cos\omega't)} \leq -\frac{2\pi\omega'\chi R^2}{T_0^2} \cong 666.6 \text{ V/K},$$

that is six orders of magnitude bigger than conventional of iron sample at rest at environment temperature.

More over since the transverse oscillating Thomson voltage depends on the sign of the thermal field pulsation ω' it is possible to control thermal emission by rotation, using the out of equilibrium effective Barnett magnetic field of (1) and the oscillating radial electric field of (30).

In fact, in accordance with new recent approach to non reciprocal photonics and tunable thermal emissivity on metamaterials [29,30], assuming Stefan-Boltzmann law it can be introduced a chiral dynamic tunable thermal emissivity

$$(48) e(T, \Omega) \propto \frac{\operatorname{div} \vec{P}_T(T, \Omega)}{(T^4 - T_0^4)},$$

with $\vec{P}_T(T, \Omega)$ an out of equilibrium electromagnetic Poynting vector proportional to heat torque transfer and to the dynamic magneto Seebeck coefficient $S(T)$

$$(49) \vec{P}_T(T, \Omega) = \frac{-S(T)\nabla T \times \vec{B}(T)}{\mu}.$$

Using equation (2) and (4) it can be rewritten as

$$(50) \vec{P}_T(T, \Omega) = \frac{b(T)S(T)\vec{\Omega} \times \nabla T}{\mu},$$

showing that the thermal emissivity of (48) implements chiral polarized thermal radiation emitted by rotating conductors exposed to chopped laser beam which could be detected looking for a dynamic nonlinear magneto Kerr effect.

We note that the effective magnetic Barnett magnetic field of (1) can be associated to a gauge breaking out of equilibrium magnetic vector potential $\overrightarrow{A_T(T)}$, defined by

$$(51) \text{rot} \overrightarrow{A_T(T)} = \overrightarrow{B(T)},$$

in accordance with recent investigations on Extended Electrodynamics, thermal induced gauge breaking effects and dynamic thermal management through magnetic field control [31–33]. This new out of equilibrium gauge breaking electrodynamic framework might be useful, we hope, to investigate the role of thermoelectric effects on out of equilibrium electrodynamics of neutron stars [24,25] and to implement chiral control of polarized thermal emission of ferromagnetic rotating disks, enhancing performances of magnetic random access memory devices and magnetic storage technology.

4. Conclusions

We illustrate in this work a new dynamic chiral Thomson effect self induced on rotating conductors exposed to chopped laser beam due to an out of equilibrium Barnett magnetic field associated to a rotational thermal Hall effect. We showed that this new dynamic non linear framework allows to implement a novel rotational chiral approach to thermal management implemented by structured helical thermal waves transporting angular momentum which propagates on the rotating disks. We proved the existence of a dynamic chiral Thomson voltage which can be used to control and improve the performance of rotating thermoelectric devices and to enhance dynamically magnetic phase transitions, giving an estimate of the average Curie temperature fluctuation on an iron sample.

We showed that the A.C. Thomson voltage induced on rotating disks can be associated to a gauge breaking thermal Poynting vector, deducing a chiral dynamic tunable thermal emissivity, which might be useful to implement chiral control of polarized thermal radiation on ferroelectric materials. Finally, we hope that our theoretical proposal might stimulate experimental investigations on the coupling between non Fourier heat diffusion and thermal super radiance either of rotating quantum material that of rotating neutron stars.

Author Contributions: Conceptualization, G.B.; methodology, G.B; validation, G.B, and R.L.V. ; formal analysis, G.B.; investigation, G.B.; writing—original draft preparation, G.B.; writing—review and editing, G.B. and R.L.V.; funding acquisition, R.L.VY. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding. “The authors have reviewed and edited the output and take full responsibility for the content of this publication.”.

Conflicts of Interest: The authors declare no conflicts of interest.

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