The Descartes Code (Spin Orbital Rotation of Photons)—IV. The Harress-Sagnac Color Excess in the Rotation Curves of Galaxies

Jiří Stávek*

1. Introduction

In 1933, Fritz Zwicky analyzed the color excess in the rotation curves of galaxies in the Coma cluster [1]. Zwicky could not explain the excess Doppler effect using the gravitational redshift [2] or using the cosmological redshift [3]. Therefore, Zwicky formulated the significant bifurcation point in the history of astrophysics: the postulation of an unknown dark matter to interpret that excess Doppler effect. This color excess was later confirmed in many observations by experimental astrophysicists, e.g., [4]–[11]. Since that time astrophysicists and physicists developed many sophisticated methods in order to discover those unknown dark matter particles. However, until now there is no positive detection of those dark matter particles, e.g., [12]–[15]. One proposal how to avoid that unknown dark matter was the MOND model introduced by Milgrom in 1983 [16] and further developed by his scholars, e.g., [17]–[23].

The aim of this contribution is to come back to Zwicky’s bifurcation point formulated in Pasadena on February 16, 1933. Can we propose an alternative interpretation of that observed color excess in the rotation curves of galaxies?
2. THE ZWICKY’S BIFURCATION POINT IN 1933—TWO PATHS: AN UNKNOWN DARK MATTER AND AN UNKNOWN COLOR EXCESS

In 1933, Fritz Zwicky studied the color excess in the rotation curves of galaxies [1] and described his position as: “It must be said that none of the theories proposed so far is satisfactory. All have been developed on an extremely hypothetical basis. None of them has succeeded in uncovering any new physical relationships in practice.” In order to interpret the excess of the Doppler effect he postulated an unknown dark matter—Fig. 1.

In 1957, Zwicky’s enigma was “improved” by his statement [24]: “Another more difficult question is, whether or not light had the same properties when it left a very distant galaxy as when it arrived on Earth.” Can an observer on the Earth unknowingly modify these old photons in his/her gravitational field using the applied instruments? Fig. 2 schematically shows that we are in a difficult situation.

In order to solve Zwicky’s enigma, we applied the Descartes code—the old rejected color theory based on the rotation of light globules (the spin-orbital rotation of photons), e.g., [25]–[36]. This behavior of photons was experimentally revealed during the last three decades as the “rotational Doppler effect”, e.g., [37]–[44]. This rediscovered old model of colors can be newly applied for the interpretation of experimental data in modern physics [45]–[49].

3. THE HARRESS-SAGNAC ROTATING INTERFEROMETERS WITH COLOR EXCESS

The history of rotating interferometers is very well described in the published literature, e.g. [50]–[57]. The significant role belongs to the experiments of Harress [58]–[61] and Sagnac [62], [63]. During the past hundred years numerous scholars proposed many models for the interpretation of the observed interference effect in those rotating interferometers. E.g., Einstein [64] interpreted the Harress’ experiment using the special theory of relativity and excluded the color change of photons in the rotating interferometers. Max von Laue [65] applied general relativity to the interpretation of Harress’ experiment and concluded that spinning or accelerating an interferometer creates a gravitational effect leading to the time difference in both paths.

Malykin [56] in his very influential review with 290 references separated correct and incorrect explanations of the Sagnac effect. E.g., several Soviet physicists interpreted the Sagnac effect as a manifestation of the classical Doppler effect with the color change of photons in the rotating interferometer. Malykin classified this interpretation as incorrect. In 2001, Kupryaev [66] introduced the Sagnac vortex optical effect as the modification of photon properties in the rotating interferometer.
Inspired by these numerous published interpretations of the Sagnac effect, we will try to describe
the events in rotating interferometers using the old Descartes’ color theory—rotating light “globules”
(spin-orbital rotation of photons). Fig. 3 depicts the travelling of photons in opposite directions and
their meeting after one round trip. There were published numerous hundred papers describing this
situation.

Table I summarizes formulae describing properties of photons travelling in opposite directions in
the rotating interferometer.

<table>
<thead>
<tr>
<th>Photon in the direction of the rotation</th>
<th>Photon property</th>
<th>Photon in the opposite direction of the rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency ( v = \nu_0 ) ( 1 + \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td>Frequency ( v = \nu_0 ) ( 1 - \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td></td>
</tr>
<tr>
<td>Wavelength ( \lambda = \lambda_0 ) ( 1 - \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td>Wavelength ( \lambda = \lambda_0 ) ( 1 + \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td></td>
</tr>
<tr>
<td>Local time ( t = t_0 ) ( 1 - \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td>Local time ( t = t_0 ) ( 1 + \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td></td>
</tr>
<tr>
<td>Momentum ( p = \hbar ) ( 1 + \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td>Momentum ( p = \hbar ) ( 1 - \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td></td>
</tr>
<tr>
<td>Energy ( E = h\nu_0 ) ( 1 + \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td>Energy ( E = h\nu_0 ) ( 1 - \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td></td>
</tr>
<tr>
<td>Temperature ( T = T_0 ) ( 1 + \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td>Temperature ( T = T_0 ) ( 1 - \omega R/c ) ( \sqrt{1 - (\omega R/c)^2} )</td>
<td></td>
</tr>
</tbody>
</table>

The phase shift \( \Delta \varphi \) of interference fringes with a fringe displacement will be proportional to the time
difference \( \Delta t \) as it is expressed in (2):

\[
\Delta \varphi = \frac{2\pi c}{\lambda_0} \Delta t = \frac{2\pi c}{\lambda_0} \frac{4\pi R^2 \omega}{c^2 \sqrt{1 - (\omega R/c)^2}} = \frac{8\pi^2 R^2 \omega}{\lambda_0 c \sqrt{1 - (\omega R/c)^2}} \approx \frac{8\pi A \omega}{\lambda_0 c} \quad (2)
\]
Equations (1) and (2) in these approximations are identical with formulae derived using many other interpretations. In order to distinguish between those numerous interpretations of the Sagnac effect we propose to study rotating interferometers in more detail focusing on the photon properties: frequency, wavelength, local time, momentum, energy, and temperature.

4. The Harress-Sagnac Color Excess in the Rotation Curves of Galaxies

The very old (1637) Descartes’ color theory [25] based on the rotation of “light globules” can be the “lost key” to how to crack the mysterious color excess in the rotation curves of galaxies and other rotating objects at cosmological distances. In this model, the photon escaping from rotating objects modifies its rotational velocity as (3):

\[
e_{\text{rotational}} = c \left(1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}}} \left(\frac{R}{R_{\text{CORE}}}\right)^x}\right) = 299792458 \text{ ms}^{-1}
\]

where \(R_{\text{CORE}}\) is the size of the galaxy core (in Zwicky’s notation from 1937 [6]), and \(R\) is the distance of that object from the center of the galaxy. The exponent \(x\) equals \(x = 1\) for the core of the galaxy, however, for the shell structure the exponent is corrected for the mass \(M\) acting on the rotating object and the escape velocity of photons from rotating objects influenced by the Newtonian rotational velocity of that object. Table II summarizes the rotational velocities of photons emitted at various parts of the galaxy.

The formulae for the observed blue/redshifts given in Table II are shown in Fig. 4 as the APPARENT rotation velocities. The word “APPARENT” comes from the works of Hubble, Humason, and Zwicky.

5. The “Geocentric” Milgrom Constant

Zwicky’s enigma described in Fig. 2 consists of two separated parts – the source modifies the photon properties and the receiver modifies the photon properties in an unknown mechanism. The first part of this Zwicky’s enigma was cracked in this contribution using the Harress-Sagnac color excess. The second part of this puzzle could be solved using the empirical Milgrom constant derived from rotation curves of galaxies [16] \(a_{\text{MILGROM}} = (1.2 \pm 0.1) \times 10^{-10} \text{ ms}^{-2}\). Stávek [48] employed the old Gerber’s retarded potential [67] in order to derive the influence of the Solar gravitational field on photons from distant objects (4):

\[
a = \frac{GM_\odot}{(AU)^2} \left(1 - \frac{GM_\odot}{(AU)^2}\right) = \frac{GM_\odot}{(AU)^2} \left(1 + 2 \frac{GM_\odot}{(AU) c^2} + \ldots\right)
\]

where \(AU\) is the astronomical unit. For the second order, we get a value of acceleration identical to the empirical Milgrom constant (5):

\[
a_{\text{MILGROM}} = 2 \frac{G^2 M_\odot^2}{(AU)^4} c^2 \approx 1.171 \times 10^{-10} \text{ [ms}^{-2}]\]

which is a surprising coincidence and could bring us new valuable information about the influence of the Solar gravitational field on photons from distant objects. The reality of (5) could be tested at the surface of Mercury (at \(R = 0.4667 \text{ AU}\)) and at the surface of Mars (at \(R = 1.524 \text{ AU}\)). Table III summarizes the predictions of (5) for these planets in the Solar System.

We propose to perform this experiment in the Solar gravitational fields near Mercury, and Mars. This experiment could be very valuable for the estimation of the reality of Descartes’ code. The joint project ICURE (India, China, United States of America, Russia, and European Union) could bring new data for the properties of cosmological photons in the Solar gravitational field near the surface of Mercury, Earth, and Mars. This experiment can reveal to us if our gravitational models are universal or “geocentric”.

The MOND scholars collected many significant data to test the Tully-Fisher empirical relation [68] where the Milgrom constant \(a_0\) plays an unknown significant role. Milgrom in his pioneering paper [16] formulated the relation for the rotation curve of galaxies where \(V_\infty\) is the asymptotic circular velocity and \(M\) is the total mass of the galaxy:

\[
V_\infty^4 = a_0 GM
\]

This formula plays a dominant role in the papers of scholars of MOND, e.g., [69]–[74]. Do we understand the physical meaning of the Milgrom constant \(a_0\)?
The Descartes Code (Spin Orbital Rotation of Photons)—IV

TABLE II: PHOTON PROPERTIES IN THE ROTATING GALAXIES

Rotational velocity of photons in the CORE of a galaxy for $R \leq R_{\text{CORE}}$

$$
\varepsilon_{\text{rotational}} = c \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right)
$$

Rotational velocity of photons in the SHELL of a galaxy for $R \geq R_{\text{CORE}}$

1. “Pure” Harress-Sagnac effect

$$
\varepsilon_{\text{rotational}} = c \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right)
$$

2. Modification for the effect of mass $M$

$$
\varepsilon_{\text{rotational}} = c \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right) = c \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right)
$$

3. Modification for the effect of mass $M$ and the escape velocity at $R$

$$
\varepsilon_{\text{rotational}} = c \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right) = c \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right)
$$

4. “Pure” Doppler effect

$$
\varepsilon_{\text{rotational}} = c \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right)
$$

5. Observed frequency of photons at $R$

$$
\nu = \nu_0 \frac{1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}}}{1 - \left( \frac{2GM}{R_{\text{CORE}} R} \right)} \approx \nu_0 \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right)
$$

6. Observed wavelength at $R$

$$
\lambda = \lambda_0 \frac{1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}}}{1 - \left( \frac{2GM}{R_{\text{CORE}} R} \right)} \approx \lambda_0 \left( 1 \pm \sqrt{\frac{2GM}{R_{\text{CORE}} R}} \right)
$$

Fig. 4. The observed blue/red color excess in rotating objects expressed as the APPARENT rotational velocities at $R$ (based on Zwicky’s paper [6]).

6. HOW TO CRACK THE ZWICKY’S ENIGMA?

Zwicky formulated a very mysterious dilemma for the interpretation of color excess observed in the rotating objects in cosmological distances. Is there any other possible interpretation of the color
TABLE III: Prediction of the Value of Milgrom Constant at Mercury and Mars

<table>
<thead>
<tr>
<th>Planet</th>
<th>Distance in AU</th>
<th>Milgrom constant $[10^{-10} \text{ ms}^{-2}]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.4667</td>
<td>11.52 prediction</td>
</tr>
<tr>
<td>Earth</td>
<td>1</td>
<td>1.171</td>
</tr>
<tr>
<td>Mars</td>
<td>1.524</td>
<td>0.3308 prediction</td>
</tr>
</tbody>
</table>

Fig. 5. Zwicky’s enigma: do we understand the observed color excess in the rotation curves of galaxies? Do we modify these photons in our local gravitational field during their observation?

Fig. 5. Zwicky's enigma: do we understand the observed color excess in the rotation curves of galaxies? Do we modify these photons in our local gravitational field during their observation?

Fig. 6 schematically surveys the possible solution of Zwicky's enigma: 1. Harress-Sagnac color excess in the rotation curves of galaxies, 2. “geocentric” Milgrom constant at the observer laboratory.

7. Conclusion

This contribution is based on the old, forgotten, and rejected Descartes’ color theory based on the spin-orbital rotation of “light globules”. This Descartes’ model of photons emitted from rotating distant stars can newly interpret the observed color excess in the known Doppler effect as the Harress-Sagnac effect.

1. We propose to come back to Zwicky’s bifurcation point formulated in 1933 when Zwicky postulated an unknown dark matter. We propose to newly study photon properties coming from distant rotating objects.

2. The formulae for the photon properties in the rotating interferometers were presented: frequency, wavelength, local time, momentum, energy, and temperature.
3. The formulae for the color excess in rotation curves of galaxies were presented based on Zwicky’s model of galaxies with the core-shell structure.
4. The Milgrom constant $a_0$ was interpreted as the acceleration of distant photons in the Solar gravitational field at the distance of 1 AU from the Sun.
5. We propose to test this new formulation of the Milgrom constant near the surface of Mercury and Mars in order to reveal if our gravitational models are universal or “geocentric”, valid near the Earth only.

ACKNOWLEDGMENT

We were supported by the contract number 0110/2020.

CONFLICT OF INTEREST

Author declares that there is no conflict of interest.

REFERENCES
