The EM properties of light

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Abstract: The size of spectral line shifts, caused by moving light sources, as quoted in various scientific articles, clearly depends on the choice of the measuring instrument. The Fabry-Perot interferometer (FPI) responds differently to the changes of speed of light source as the spectrometer based on diffraction grating. It is possible that these two instruments are not equally sensitive to the frequency as to the wavelength of the light. Analysis of the structure and the construction of both instruments shows that FPI interferometer is sensitive only to the wavelength of light waves, while the spectrometer based on diffraction grating is sensitive to the wavelength and to the frequency of light. Moreover, in the case of different response of instruments to the changes of the speed of light source we have to ask ourselves if the moving light source affects the frequency differently from the wavelength of the light. In this case we have to allow the hypothesis that, in accordance with the equation $c = f.\lambda$, the moving light source affects the speed of light.

Keywords—About of light, Fabry-Perot interferometer, diffraction grating spectrometer.

I. Introduction

There exist many scientific articles describing measurements of Doppler shift of the spectral lines caused by moving light sources. In this paper we analyse these measurements with an intention to call attention to the remarkable differences between the results, and we propose possible explanation for them.

With the intention to examine the properties of light, we have chosen those moving objects in the universe where the speed of moving light sources is identified by different methods and where the observed speed of light source is fully known.

We have also chosen those moving objects where the light from moving light source may not be disturbed by different phenomena in the universe.

Comets and the solar flares are appropriate objects for the moving light sources. The source of light from these moving objects is strong and well defined.

Observation of sunlight and comets has a long tradition, so we were able to examine a large amount of published articles, containing the measurement results.

II. Measurement of spectral line shifts of the light coming from comets and solar flares

The speed of comets is in the range of few dozens of km/s, while the speed of solar flares attains several hundreds of km/s. Each of them emits sufficient light energy which allows successful measurement of spectral lines.

In the articles referenced in this paper we have noticed significant differences between the measurement results of spectral line shifts related to the light coming from moving light sources measured by the interferometers (Fabry-Perot interferometer) [1] on one side and the measurement results of spectral line shifts measured by spectrometers based on diffraction gratings (EIS EUV Imaging Spectrometer) [2].

Differences in measurement results are similar in all occasions. The measurements, described below, can be taken at the same location and the same light source.

The difference between the measurement results can be explained by different sensitivity or diverse nature of instruments, measuring the frequency or the wavelength of the light respectively.

A. Measurement of solar flares

Spectrometer based on diffraction gratings is showing the spectral line shifts and is proving that the solar flares are reaching a speed up to several hundred km/s (New techniques for the characterization of Dynamical Phenomena in solar coronal images) [3]. Comparable speed of solar flare was estimated on the basis of visual optical observation of solar flare through the telescope, as it is described in the above mentioned article.

On the other hand, the appropriate spectral line shifts and corresponding speeds of solar flares in the solar corona are not detected by FPI interferometer (Systematic errors in measuring solar magnetic fields with a FPI spectrometer and MDI) [4]. The spectral line shifts are not presented in this case. It is mentioned in the article that spectral line shifts are not presented due to some systematic error.

In the case of FPI interferometer the spectral lines are obviously recognized. The question is why the FPI interferometer does not detect any spectral line shift of the observed spectral line as a consequence of the speed of bright particles in the solar flare.

However, this result is surprising and deserves further investigation.

Unresponsiveness of FPI interferometer to the light source movement in general is shown in other similar measurements as well [9], [10], [11]. In the literature one cannot find any measurement, where the FPI interferometer detects the movement of solar flares.

B. Measurement of the comet

Similar differences are detected in the measurement results of the comet speed, if the comet is observed once by FPI interferometer and another time by the spectrometer based on diffraction gratings.

Spectrometer based on diffraction gratings shows the comet speed in the size of few dozens of km/s (Atomic

Oxygen in the Coma of Comets) [5]. Comparable speeds are estimated in the visual observations of the comets.

When we direct the FPI interferometer towards the comet, FPI does not show the expected spectral line shift as the result of the comet movement (6300 Large Aperture Photometry of Comet Hale-BOPP) [6]. Figure 1 in the above mentioned article shows the diagram of the measurements of the Hale-BOPP comet head in the year 1997.

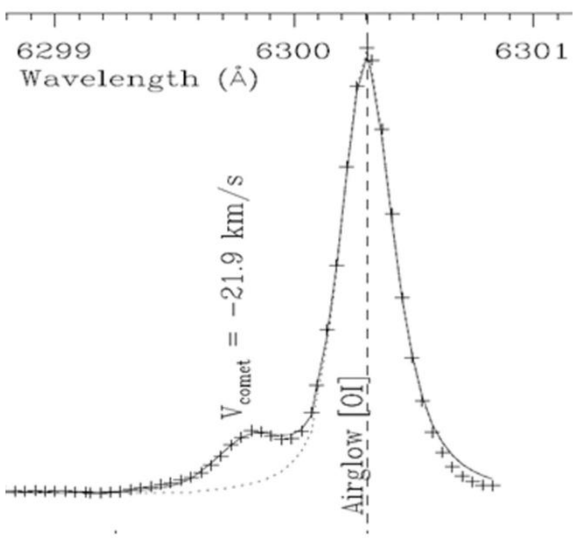

Fig. 1

The comet represents the moving light source. Consecutively we could expect the spectral line shift in the whole observed light flux coming from the comet. The measurement results taken by the Fabry-Perot interferometer shows in Fig. 1 that only an insignificant part of the light flux at the wavelength of 6300.304 Å causes the shift of the spectral line according to the Doppler low. The main part of the light flux causes no spectral line shift at all.

The author of the article is giving the following hypothetical explanation. On its way towards the Earth the light from the comet is hitting the atmospheric particles, which absorb the light and immediately after that emit it with different wavelength. This phenomenon, shown on Fig. 2, is known as Rayleigh scattering [7].

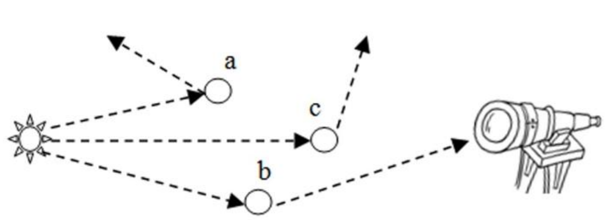

Fig. 2

Photons hit the atmospheric particles and after that, in general, the atmospheric particle emits photon in an arbitrary direction, as it shown in the case *a*. In the case *b*, the particle emits photon precisely in the direction of FPI interferometer. In general, the FPI interferometer can not detect it, because the FPI interferometer is directed towards the light source and not towards the particle, The photon, coming from the particle *b*, cannot be detected by FPI, because it is coming out of FPI.viewing angle.

The FPI interferometer detects only the photons that are emitted by the light source, directed towards the atmospheric particle, which is placed precisely between the light source and FPI interferometer, and emitted precisely in direction towards the FPI, as it shows in the case c.

Emitted photons, related to the case *c*, are very infrequent, what is the reason, that in this case, the photons are not detected by the measurement instrument. This explanation of Rayleigh scattering effect is confirmed also by the measurement results of spectral line shift, obtained by the diffraction gratings spectrometer. The spread of the wavelength (Rayleigh scattering) is not detected at all in the case, where the spectrometer, based on diffraction gratings, is used (GAIA accuracy on radial velocities assessed from a synthetic spectra database) [8].

The reason why the spectral line shift is not presented can be therefore caused only by the properties of the FPI and grating spectrometer and not by the change of the wavelength of the light in the atmosphere on the way from the comet to the measuring instrument.

We can conclude that FPI interferometer does not detect the expected spectral line shifts of the light coming from the fast moving comets, while the spectrometer based on diffraction gratings does detect expected values of the spectral line shifts.

III. Discussion about the results

The measured results of the spectral line shift from moving light source made by FPI spectrometer are taken from [6] and shown in Fig. 3.

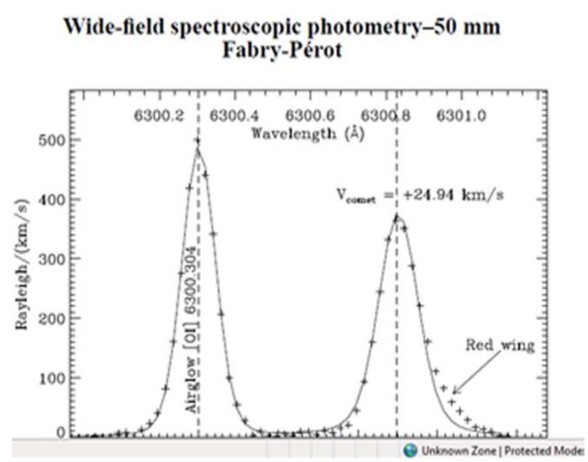

Fig. 3

The left peak in the diagram corresponds to the part of light flux where the spectral line shifts depends only on the selected spectral line but not on the speed of comet.

The right pick in the diagram corresponds to the part of light flux where the spectral line shifts depends on the selected spectral line and also on the speed of comet.

The amount of the light flux in the right peak and in the left peak depends on the selection and the construction of the measurement instrument.

The diagram in Fig. 1 shows the case where only an insignificant part of the light flux affects the spectral line shift in with regard to the speed of comet.

Different results are obtained in case if the spectrometer based on diffraction gratings is used. In this case the whole light flux has influence on the spectral line shift in accordance with Doppler low. The measurement results show in this case only the right peak without the left peak as it is shown in Fig. 3.

In general, different distributions of light fluxes or corresponding peaks are possible, as it is shown for the WHAM interferometer measurement results in Fig. 3.

A. The frequency and the wavelength of light respond differently to the change of the speed of light source

The spectral line shift depends on the frequency or on the wavelength of the light respectively. Because the instruments show two different spectral line shifts measuring the light from the moving light source, we have to describe both of them by its own function. The first spectral line shift, corresponding to the right peak in Fig. 3, can be described by the function f1(f,λ) and the second spectral line shift corresponding to the left peak, can be described by the function f2(f,λ).

With regard to the measurement results we can conclude, that the f1(f,λ) is in accordance with Doppler low while the spectral line shift f2(f,λ) depends only on the spectral line selection. For selected spectral line f2(f,λ) is constant and does not depend on speed of light source.

We come to the following conclusion. The function f1(f,λ) depends on the speed of light source in accordance with Doppler law what means that at least one variable (f or λ) depends on the speed of light.

Otherwise, the function f2(f,λ) depends only on the spectral line selection and not on the speed of light source, what means that the function f2(f,λ) does not depend on both variables (f and λ). The function f2(f,λ) depends only on one variable which is either frequency or wavelength and this variable does not depend on the speed of light.

If the change of the light source speed would affect both entities f and λ, it should affect the value of f2(f,λ) on the interferometer. We can conclude that more in depth study of basic properties of the light is needed.

B. Does the speed of light source affect the speed of light?

Based on the above mentioned measurements we can propose the hypothesis that the speed of light source affects only one entity of light: frequency or wavelength. The second variable does not change as a function of the light source speed.

According to the equation $c = f.\lambda$, we could expect, that the speed of light source affects the speed of light from the moving light source.

IV. HOW TO EXPLAIN DOUBLE NATURE OF SPECTRAL LINE SHIFTS?

Our further attention will be addressed to the basic principles of applied measurement instruments and their constructions.

Two peaks in the diagram in Fig. 3 are common and can be easily explained. However, the measurement diagrams usually present only one peak.

In general, the spectral line shifts, shown in the FPI interferometers, do not depend on the speed of light source. Such measurement instrument is described in the article: "Evidence for moving features in the Corona from Emission Line Profiles Observed during Eclipses", Moscow 1987 [9].

This and also other similar articles [10], [11], describe that FPI interferometers do no detect the spectral line shifts in accordance with the speed of light source.

On the other hand, the spectrometer,based on diffraction gratings, is showing the spectral line shifts in accordance with the Doppler law and the speed of light source.

Considering measurement results from various measurement instruments, we recognized, that measurement instruments mostly create only one of two peaks shown in Fig 3.

In general, FPI interferometer creates only left peak in Fig 3., since the spectral line shift depends only on the selected spectral line and not on the speed of light source. This spectral line shift is described by the function f2(f,λ).

In general, the spectrometer, based on the diffraction gratings, creates the right peak in Fig. 3., where the spectral line shift is in accordance with the Doppler law. This spectral line shift is defined by the function f1(f,λ).

A. Sensibility of FPI interferometer

The mirrors of telescopes direct the light to the focus of the mirror, regardless of the speed of the light source. We can therefore conclude that the light reflection is symmetrical in all occasions and that it does not affect the wavelength of the light.

The Fabry-Pérot interferometer operates on the principle of light reflections between two semi conductible mirrors. On the exit we find more parallel rays. When the rays are in phase, they create the interference. The interference of the light depends on the light wavelength and on the distance between the mirrors. FPI interferometer is not sensible to how often the light waves are passing the mirrors. It means,that FPI interferometer is not sensitive to the speed of light and to the frequency of light.

Consequently we can establish, that measurement result, measured on the base of FPI interferometer depends only on wavelength. The function f2(f,λ) from Fig. 3 we can define as f2(λ).

In previous we establish that only one parameter of light depends on the speed of light. Because of the Fabry Perot interferometer in general does not detect the spectral line shifts we can establish that the wavelength is therefore the light parameter that is not depending on the speed of light changing.

B. Sensibility of diffraction gratings spectrometer

The interferometer based on the diffraction gratings deflects the light as it is shown in Fig. 4. The fall in front of the light waves is shown by the line AD in Fig. 4. The line AC presents the leaving light wave front after passing the light through the diffraction gratings.

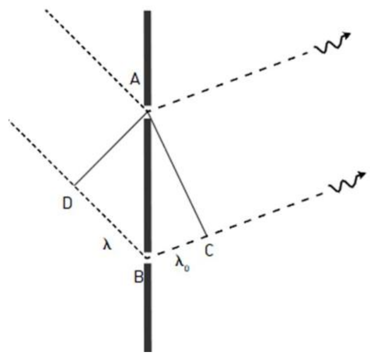

Fig. 4

Leaving EM waves create the interference in conditions, where between the points D and C is a whole number of wavelengths.

In the case of equal wavelengths between points DB and BC the measurement results should be also the function of wavelength and not function of the frequency. That is f1(λ) and not f1(f,λ).

But it is not!

The measurement results, measured by diffraction gratings spectrometer are the function of wavelength and also the function of frequency as it shows the right peak in Fig. 3 and as it defines function of the right peak f1(f,λ).

C. The diffraction grating affects the wavelength of the light.

The both mentioned measurement instruments are differently responding to the speed of light source. The respond of FPI interferometer is in general defined by function f2(λ). The respond of the spectrometer based on the diffraction grating is defined by the function f1(f,λ) and shown on Fig. 3.

After analysing several assumptions to explain the above mentioned measurement results, we found only one explanation is possible. The light from the moving light source comes with the speed that is not necessarily the 'speed of light'. The term 'speed of light' in this case means the equal speed of light in all occasions.

The diffraction grating affects the speed of light and the outgoing speed of light can be different from the incoming speed of light. The outgoing speed of light is in this case in physics known as in all occasions equal speed of light.

The diffraction grating affects the wavelength of the light, while the frequency keeps the same in accordance with function c=f. λ

The wavelength in the relation from D to B in Fig. 4 is therefore not the same as the wavelength in the relation from B to C.

If the wavelength in the relation from D to B could be different as the wavelength in the relation from B to C as consequence of the speed of a light source, then the number of wavelengths in relation from D to C depends on the speed of light source, the speed of light from moving light source and also from frequency of light.

The measurement result is in this case depends on the frequency and the wavelength as the measurement results response have been measured by spectrometer based on diffraction gratings.

V. Model of the light waves

At the end we would lake to have a clear image about the light propagation in previously described conditions, where the speed of light source affects the frequency of light but not the wavelength of light.

These presumptions correspond with model where the light propagates with the speed of light from the light source in concentric circles in all directions. The speed of light means equal speed of light in all conditions. The forms of circles do not depend on the speed of observer.

The moving observer can come for example near the light source. In this case he is coming near to the propagating light fronts. He meets the wave fronts more frequently. He therefore perceives the higher frequency what is in accordance with the measurement results and Doppler law.

Independently from the speed of observer, he detects in all occasions the same wavelength of the light. The speed of light does not influence the light wavelength what is also in accordance with the measurement results.

VI. The speed of light from the moving source has not been measured directly yet.

Recognition of this hypothesis requires from us the review of measurement results, related to the speed of light over time.

In the last hundred years we can find many measurements of the speed of light, measured from the stationary light sources that have been executed in different ways (How is the speed of light measured?) [12] All of the measurements have been implemented in conditions, where the light source is stationary regarding the observer. In the above mentioned paper it is recorded that the speed of light has been measured in the following years: 1676; Author: Ole Roemer; Method of Jupiter's satellites, 1726; James Bradley; Stellar Aberration; 1849; Armand Fizeau; Toothed Wheel, 1862; Leon Foucault; Rotating Mirror; 1879; Albert Michelson; Rotating Mirror [10]; 1907; Rosa, Dorsay; Electromagnetic constants; 1926; Albert Michelson; Rotating Mirror; 1947; Essen, Gorden-Smith; Cavity Resonator, 1958; K. D. Froome; Radio interferometer; 1973; Evanson et al; Lasers, 1983; Adopted Value.

Above mentioned measurements does not mention the measurements were the light sources are moving, although for such measurements also there are known technological solutions as a method of measurement[1].

The results of the measurements of the existence of ether, which are more than a hundred years old, are known. Michelson and Morley made an experiment, proving if exist the ether as a medium for the transmission of light. Articles are not uniform in this, are the results of these measurements also evident the equal speed of light in all conditions. Contemporary articles and other records (Michelson-Morley experiment - Wikipedia) [14] do not mention the results of these measurements in sense of measuring the speed of light coming from a moving light source.

VII. The Consequences

The measurement of the speed of light from the moving light source that would unambiguously and certainly answer the question on the speed of light from a moving light source has not been performed yet. In all conditions equal speed of light, although it is not unambiguously measured, is the basis for many physical principles [15], [16], [17], [18]. The measurement of the speed of light from a moving light source therefore deserves to be carried out. The results would either confirm or deny the hypotheses that the speed of light depends on the speed of moving light source.

What should be the consequences when the speed of light source impact the speed of light? Above described model of light propagation could have an impact on photon energy by Planck's Law, on Maxwell's laws, on the Stephan Boltzmann law, that define the radiation of black body on the special theory of relativity, etc?

All mentioned laws are final and do not need any adaptation in the case of stationary light source. In the case of moving light source they need a completion with a new variable.

The speeds of light sources on the Earth are very small compared to the speed of light; only up to 1000 m/s. The small speeds of light sources therefore have in general no practical impact on the above mentioned laws in our life. It does not matter in our environment, if we use the basic or upgraded legality.

But, all of these laws are important in assessing the distance, velocity and acceleration of high speed celestial bodies in space.

VIII. Conclusion

Measurement of the speed of light, coming from moving light sources is possible, based on the measurements of the light from sky bodies, in the manner, described in this article, as well as in the laboratory environments (Curtained Universe–Speed of light) [19].

The aim of the paper is to draw attention to inconsistencies in the measurement results, regarding the speed of light coming from moving light source.

Physics requires for its credibility the unambiguous measurement of the speed of light coming from moving sources, which should be performed even in several ways, especially because there are known measuring methods and technology which can carry out these measurements.

[1] We have considered three measurement methods with regard to the light from the comet or solar flare: (1) autonomous measurement of the wavelength, (2) autonomous measurement of the frequency and (3) laboratory measurements of laser beam interference such as measurement of laser beam reflection from vibratory mirror with highly sensitive Michelson interferometer based on optical fibre.

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