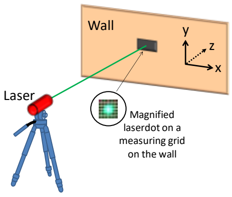


On the inconclusiveness of the results from the Eddington 1919 solar eclipse mission to measure the bending of light.

Private communication/publication

Etienne Brauns[a]

1.0

Keywords: Arthur Stanley Eddington, Frank Watson Dyson, light bending, gravity, sun, solar eclipse, star light, Einstein, relativity, paradigm, light, ray of light, laser, laser pulse, laser beam, photon, real space, real velocity, real location

Abbreviations: CS (contemporary science), CPBD (contemporary paradigms believer and defender), RS (real space), RV (real velocity), VS (virtual space), MWF# (My Website Figure) (a Figure at www.absolute-relativity.be ; including references to dynamic Figures through their internet web link since it is not possible to directly implement dynamic/animated time stamp type of Figures in a Word or PDF based publication/document)

Dynamic figures in this publication and in the publications (1,2,3,4,5) are referred to as e.g. MWF2 (see *Abbreviations*). By clicking the link in Table 1 those dynamic figures will automatically open in your web browser.

Table 1 : dynamic MWF figure and the link

MWF#	Link
MWF2	www.absolute-relativity.be/images2/G6_Animation.gif

Note : A detailed discussion can be found within the extended publication (1) of over 400 pages which is downloadable at the website indicated in [a)]. The extended publication is informing in more detail about the existence/proofs of multiple flawed paradigms based on light/photons within CS and about important applications (on our planet and in space) resulting from those views. This publication and the preceding publications (2,3,4,5) are extracted from (1) and are intended as a series in the project indicated at ResearchGate entitled "*Karl Popper's type of falsification, through theoretical and experimental anomalies, of multiple contemporary paradigms based on light phenomena*". The information in (1),(2),(3),(4),(5) and the website was registered in front of a notary and, in combination with the patent text, thus ensuring an author's copy right protection. The principle and result of the laser experiment (MWF2) was already published in a (notary registered) patent text and also already published at www.absolute-relativity.be.

a) Private research contact : all contacts should go through the Contact facility at the Home page of www.absolute-relativity.be

(1) Etienne Brauns, *A shattered Equivalence Principle in Physics and a future History of multiple Paradigm Big Bangs in "exact" science ?* ; this extended (notary registered) publication can be downloaded at http://www.absolute-relativity.be

(2) Etienne Brauns, *On multiple anomalies and inconsistencies regarding the description of light phenomena in contemporary science*
Website : http://www.absolute-relativity.be/pdf/MultipleAnomalies_EBrauns.pdf (version including the Annex)
Researchgate :
https://www.researchgate.net/publication/312190993_On_multiple_anomalies_and_inconsistencies_regarding_the_description_of_light_phenomena_in_contemporary_science
https://www.researchgate.net/publication/312591154_Annex_1_to_On_multiple_anomalies_and_inconsistencies_regarding_the_description_of_light_phenomena_in_contemporary_science

(3) Etienne Brauns, *On a massive anomaly through a straightforward laser experiment falsifying the equivalence principle for light.*
Website : http://www.absolute-relativity.be/pdf/ExperAnomLaser_EBrauns.pdf
Researchgate :
https://www.researchgate.net/publication/313030370_On_a_massive_anomaly_through_a_straightforward_laser_experiment_falsifying_the_equivalence_principle_for_light

(4) Etienne Brauns, *On the flawed Michelson and Morley experiment null-result paradigm*
Website : http://www.absolute-relativity.be/pdf/MichelsonMorley_EBrauns.pdf
Researchgate :
https://www.researchgate.net/publication/318969438_On_the_flawed_Michelson_and_Morley_experiment_null-result_paradigm

(5) Etienne Brauns, *On a flawed Lorentz contraction paradigm caused by an erroneous Michelson-Morley model and null-result.*
Website: http://www.absolute-relativity.be/pdf/Lorentz_EBrauns.pdf
Researchgate :
https://www.researchgate.net/publication/319128677_On_a_flawed_Lorentz_contraction_paradigm_caused_by_an_erroneous_Michelson-Morley_model_and_null-result

1. Abstract

In this publication the inconclusiveness of the results, as obtained by Eddington and Dyson in their solar eclipse mission in 1919 with respect to the bending of star light by the sun, is shown. Those results in 1919 were proclaimed as the first experimental proof of Einstein's relativity theory. However, that "proof" is no longer supported as indicated in this publication. In order to better understand the "bending of a star's ray of light by the sun" such "bending" is explained/calculated in four different approaches (the CS equivalence principle for light phenomena, the Newton's gravity based derivation, an Euler based calculation method and Einstein's calculation in his 1911 paper). The bending effect involves only a miniscule 0.875 arc seconds in the case of Newton's gravity approach and also a miniscule 1.75 arc seconds according to Einstein's theory. The consequences of such an extremely small value to be detected and measured with respect to an inconclusiveness of the results from the measurement set-up, as used by Eddington and Dyson during the 1919 solar eclipse mission, are pointed to in this publication.

2. The inconclusiveness of the results obtained from the Eddington-Dyson solar eclipse mission of 1919, to prove Einstein's relativity theory

Einstein's paper "*Einfluss der Schwerkraft auf die Ausbreitung des Lichtes*" ("*On the influence of gravitation on the propagation of light*") was published in 1911 in Annalen der Physik (p898-908). The publication can be downloaded at e.g.:
http://www.physik.uni-augsburg.de/annalen/history/einstein-papers/1911_35_898-908.pdf

In that publication Einstein suggested an experimental approach to prove his relativity theory. A "ray of light" coming from a star would be bended by the sun's mass/gravity in the case that the ray of light would pass the sun in its vicinity. Such ray of light is indicated in the literature as "a ray of light grazing the sun". Einstein calculated in that first publication a value of 0.83 arc sec (see page 908 of his paper) with respect to the bending angle of the ray of light grazing the sun. Please notice that a straight line is representing 180°, corresponding to 648000 arc sec and that 0.83 arc sec only constitutes 0.00013 % of that value of 648000 arc sec. The bending of a ray of light by the sun's gravity is thus extremely minuscule. It should be noted that, as a matter of fact, the value which he calculated in his 1911 publication was the very same as the value calculated earlier on the basis of Newton's gravity (see the approach in Appendix I 12.10.2.b and in Appendix I 12.10.2.c).

On page 908 of his paper Einstein writes "*Es wäre dringend zu wünschen, dass sich Astronomen der hier aufgerollten Frage annähmen ...Denn abgesehen von jeder Theorie muss man sich fragen, ob mit den heutigen Mitteln ein Einfluss der Gravitationsfelder auf die Ausbreitung des Lichtes sich konstatieren lässt*." ("*It is urgently recommended for astronomers to look into this ... the question should be raised if it would be possible to verify the bending of light with contemporary measuring instruments*").

Evidently it is not possible during normal daytime to observe a "ray of light coming from a star and grazing the sun" since the intensity of the light emitted by the sun itself during the day is much too high in order to be able to observe such a "ray of star light grazing the sun" and measure the bending effect. However it was known at that time that it would be possible during the short time interval of a total solar eclipse to observe the "rays of light grazing the sun" from the far stars located in a direction behind the sun and in the periphery of the sun. During a total eclipse the massive light intensity created by the sun in the direction of our planet is then adequately blocked by the moon.

Consequently, in 1919 it was Arthur Stanley Eddington and Frank Watson Dyson who organised a solar eclipse mission in that respect. The report about that mission can be downloaded at http://w.astro.berkeley.edu/~kalas/labs/documents/dyson1920.pdf. Since the conclusions from that mission by Eddington and Dyson resulted in a "confirmation" ("first experimental proof") of Einstein's relativity theory, Einstein became instantly famous. Evidently Eddington and Dyson fully shared in that fame. All this placed Einstein and Eddington worldwide in the spotlights and they both became world celebrities. Einstein

received, as it seems, the only one ever for a scientist organized, ticker parade on Broadway in New York City. Reference can be made to "*How does one become an overnight celebrity?*" and the critique on the Eddington eclipse experiments within :
http://ocw.mit.edu/courses/science-technology-and-society/sts-003-the-rise-of-modern-science-fall-2010/assignments/assn4a/MITSTS_003F10_assn4_a1.pdf

Many papers have been written on the scientific validity of this first Eddington-Dyson solar eclipse based "experimental proof" from the bending of star light by the sun, including the severe scientific doubts about the quality of (Eddington's) eclipse measurements. Since the extremely tiny effect to be detected was/is that small, it seems that the consensus in the scientific world is that the quality of the measurement set-up and obtained data was/is insufficient to be conclusive. Prof. Paul Marmet (Canadian professor in physics) has e.g. described the experimental issues (http://www.newtonphysics.on.ca/einstein/appendix2.html) and the accuracy limits during Eddington's eclipse measurements. The basis for his critique can be found within the literature reference list in Prof. Marmet's publication and on the internet. Prof. Marmet writes e.g. about the effect of atmospheric turbulence: "*Rare is the night when any telescope, no matter how large its aperture or perfect its optics, can resolve details finer that 1 arc second. More typically at ordinary locations is 2- or 3-arc second seeing, or worse*". Prof. Marmet states in his publication: "*How could one claim to observe that, if at best their precision due to atmospheric turbulence in daytime heat was several arc seconds?*". See further also Appendix I 12.10.1.

Reference can e.g. also be made to the paper "*Trust in expert testimony: Eddington's 1919 eclipse expedition and the British response to general relativity*" by Ben Almasi :
http://blogs.ub-filosofie.ro/jalobeanu-graduate/wp-content/uploads/Almassi.pdf

The paper by Almasi shows the importance of the human factor in science. The paper does not reveal a 100 % scientific clarity about a 100 % conclusiveness of Eddington's statement at that time that his eclipse experiments "*totally proved Einstein's theory*". The scatter in the data, with also stars showing no or small shifts and even higher shifts (or it seems also "shifts in the wrong" direction), the selection of stars in the analysis, the opinions of Eddington and Dyson for that matter, the opinions of CPBDs, the counter opinions of fellow scientists, etc. totally do not un-blur the situation. It all remains fuzzy up to now. It thus seems that "hard evidence of that extremely tiny bending of starlight by the sun" through such measurements was/is not there at all.

At http://www.physicsoftheuniverse.com/scientists_eddington.html the comment "*This verification of the bending of light passing close to the sun (as predicted by relativity theory) was hailed at the time as a conclusive proof of general relativity, **even if in retrospect the proof was actually far from conclusive***" can also be found. See further also Appendix I 12.10.1.

Therefore, in my opinion, the declaration at that time (even still declared now by a number of CPBDs) that Einstein's theory was proven by the results of Eddington's eclipse mission is incorrect. It seems moreover that later eclipse trials in the sixties, with of course more sophisticated equipment than the 1919 expedition, did not result either in conclusive results. This all severely questions the relevance of the Eddington eclipse paradigm as the first proof of Einstein's relativity theory.

In 12.10.2 in (1) four methods were presented explaining and/or calculating the light bending effect as a result of the sun's mass/gravity. The section 12.10.2 in a more condensed format can be found in the Appendix I, and more specifically :

a) a critique on the deduction of the bending of light on the basis of the equivalence principle is pointed to first in Appendix I 12.10.2a and in Appendix II
b) in Appendix I 12.10.2b the derivation of the equation describing the bending, as described in the literature and based on Newton's gravity, is reported on
c) an Euler method based calculation can be found in Appendix I 12.10.2c
d) Einstein's first calculation approach (1911) can be found in Appendix I 12.10.2d

3. Conclusions

The light bending results as obtained by Eddington-Dyson from the 1919 solar eclipse mission are indicated in the literature as inconclusive. Such, it seems, as a result of a lacking accuracy of the set-up being used during that eclipse mission in 1919 and as a result of disturbance parameters exceeding the required accuracy. The Eddington-Dyson 1919 eclipse mission is thus considered in literature as "*even if in retrospect the proof was actually far from conclusive"*, thereby becoming obsolete as a paradigm in CS for those CPBDs who would still be supporting the "Eddington paradigm" at this moment and even becoming obsolete as a proof of Einstein's relativity theory.

Appendix I

Note: this appendix I is a somewhat condensed version of section 12.10 in (1). The section indexes are retained from section 12.10 in (1) as well as the indexes of the equations being used in section 12.10 of (1).

12.10 Critique on the "bending of starlight by the sun" paradigm in CS

In 12.10.1 the problem is described. In 12.10.2 the theories and/or calculation approaches with respect to the bending of light by the sun can be found.

12.10.1 The actual problem of measuring the bending of star light by the sun

The bending of starlight by the sun's gravity is often considered to be proven experimentally by the Eddington solar eclipse mission in 1919. The gravity based light bending situation was/is confusing since a photon is considered not to have mass. Therefore of course a paradox arises when trying to tackle the suggested bending of a "ray of light" from a star by the sun's gravitational field. Nonetheless, a (CS based) explanation and/or calculation regarding the gravity approach, as extracted from the literature, is presented in 12.10.2. The bending of star light "grazing the sun" on the basis of Newton's gravity involves a minute value of only 0.875 arc seconds and when compared to a straight line of 180° which represents 648000 arc seconds the "bending" causes a deviation of only 0.000135 % from that straight line. The required accuracy/sensitivity of a set-up to measure on earth (during a solar eclipse) that extremely small deviation is thus very clear. Since Einstein predicted on the basis of his relativity theory a value which is only the double of the "Newton's theory based" value, the same remark holds of course. The maximum deviation from a straight line, to be measured is, in the case of Einstein's prediction of 1.75 arc seconds, still only 0.00027 % for a "ray of light" from a star grazing the sun. To be observed under the conditions of several severe measurement disturbance factors !

Moreover there is even the problem of the "aberration of light" effect, influencing such experiments (http://en.wikipedia.org/wiki/Aberration_of_light). The "aberration of light" effect is on the basis of our planet's solar orbit velocity estimated to have a range up to about 20 arc seconds! The "aberration of light" effect e.g. is thus one order larger than Einstein's relativity theory based maximum bending effect itself. As a result, regarding the needed corrections related to the "aberration of light" the scalar value of the RV vector of the observing instrument moving in RS (along with our planet) in principle needs to be known precisely. In that respect the utmost importance of a RV measuring device (of which the concept is described in (1) and in the USPTO Patent Application US2007/0222971 A1) is clear. Such device allows to measure the direction and size of the RV vector of the surveying (optical) instrument in RS and then would allow to implement the needed corrections related to the "aberration of light" effect influencing the observation.

In the discussion on the bending of a "ray of star light" by the sun, at that time one was actually trying to find/explain/distinct the values and differences between the two predictions of 0.875 arc seconds and 1.75 arc seconds. That was thus still trying to detect an extremely tiny difference between both of those values of only 1.75 - 0.875 = 0.875 arc seconds. It should be noted that the Eddington type of eclipse based star light bending observations were performed from our planet's surface while of course surveying precisely in the direction of the sun. As a result, the surveying instrument detection direction for grazing "rays of light" from stars is subjected to a high scalar value of our planet's orbit velocity vector and so, the aberration effect is expected to be large in that direction. In the more outward directions during the observation of non-grazing light from more outward stars, the aberration effect will be of course less. This reasoning illustrates once more the extremely challenging task which the researcher is confronted with when trying to perform an Eddington type of experiment. In the analysis, the direction of observation for all observed stars needs also to be implemented for aberration effect corrections (how was/is this done in the Eddington type of experiments ?) and the correct scalar values of the surveying instrument's RV would therefore be needed. As a result, in my opinion, for such type of experiments a RV measuring device as described in (1) would surely be indispensible.

A measurement and distinction of such an extremely tiny deviation definitely needs an incredible accuracy from the surveying instrument while taking into account all possible disturbances when trying to measure on earth the bending of starlight, grazing the sun. From a scientific point of view: such demanding accuracy and the inevitable presence of experimental disturbance factors (see the critiques from prof. Marmet) pictures the task of measuring the bending of starlight by the sun rather as an "impossible mission". The Eddington experiment in 1919 must have lacked, from the very start of the experiment, the required accuracy demands in that respect, to be conclusive. Nonetheless, the outcome of Eddington's measurements were at that time proclaimed worldwide as the ultimate experimental proof of Einstein's relativity theory, making the persons involved famous instantly. However at:
http://en.wikipedia.org/wiki/Tests_of_general_relativity#Deflection_of_light_by_the_Sun
it is indicated with respect to the Eddinton type of measurements on the basis of starlight: "*Considerable uncertainty remained in these measurements for almost fifty years*". So the "proof" by such measurements of the bending of light by the sun remained/remains unclear.

It is mentioned there also that another type of experiment on the basis of radio waves then would have given the proof. The latter is however countered by the views of prof. Paul Marmet on the bending of light by the sun in his paper "*Relativistic Deflection of Light Near the Sun Using Radio Signals and Visible Light*": http://www.newtonphysics.on.ca/eclipse/. In the Abstract prof. Marmet indicates: "*This paper shows how all experiments claiming the deflection of light by the Sun are subjected to very large systematic errors, which render the results highly unreliable and proving nothing*".

Also at http://www.newtonphysics.on.ca/einstein/appendix2.html prof. Marmet points to the experimental problems in Eddington's star light based measurements and the poor quality of the Sobral and Principe eclipse data.

In addition at http://relativity.livingreviews.org/open?pubNo=lrr-2001-4&page=node10.html
one can read: "*However, the experiments of Eddington and his co-workers had only 30 percent accuracy, and succeeding experiments were not much better: the results were scattered between one half and twice the Einstein value (Figure 5 at that website), and the accuracies were low*". So it seems that even "bending" values **twice** the Einstein value were measured and that succeeding experiments did not result in better values!

I can repeat here also my remark within section 12.5 of (1): "*Therefore the views as expressed in this publication regarding photon trajectories in RS can be applied also to the trajectories of electromagnetic signals in RS. As a result and in my opinion, their trajectories in RS should be modeled in the same way as described in this publication for photons. Whatever the application or signal range such as GPS or atomic clocks: the effect of the electromagnetic* *signal being locked to RS (from the moment when it is launched into RS) while the material components (e.g. atoms in the atomic clock; e.g. signal emitter) are moving at our planet's RV in RS should be definitely looked into*". So, in my opinion, that remark is also valid for e.g. radio signals as used in later experiments.

12.10.2 Various approaches to calculate the bending of starlight by the sun

There are a number of theoretical and calculation approaches regarding the bending of a "ray of light" by the sun. Those options are:

a) the "predicted" bending of light on the basis of the equivalence principle
b) the hyperbolic orbit approach according to the classic orbit equations (based on Newton's gravity) for a material object of a small mass, attracted by gravitational force by a much larger object in space (e.g. an orbit around the sun)
c) an Euler method based approximation of the hyperbolic orbit, as can be conveniently calculated, also in Excel
d) Einstein's first approach in a 1911 publication in Annalen der Physik : "*Einfluss der Schwerkraft auf die Ausbreitung des Lichtes" ("On the influence of gravitation on the propagation of light*") :
http://en.wikipedia.org/wiki/List_of_scientific_publications_by_Albert_Einstein
(including a link to the pdf document of that paper from Einstein)

12.10.2.a Bending of light by the sun's gravitation on the basis of the equivalence principle

Section 7 in (1) deals with the equivalence principle including a critique on Einstein's type of thought experiment represented in Figure 7.2 in (1) (see also Appendix II in this publication). It must then be clear (also from (1,2,3,4,5) and MWF2) that in the case of photons the equivalence paradigm in CS is flawed and therefore also the CS thought experiment in Figure 7.2 in (1) is wrong. The claim in CS that light is bending in a gravitational field on the basis of merely the equivalence principle is fictitious and does NOT save the real photon phenomena in RS.

Note: the reader can also have a look at the contents of Appendix II in this publication (not present in (1)) where the bending of light is discussed on the basis of a BBC video "*Watch this video to understand the biggest idea in physics*" which can be viewed at the internet:
http://www.bbc.com/earth/story/20151118-watch-this-video-to-understand-the-biggest-idea-in-physics
In Appendix II it is indicated with respect to that BBC video that even a substantial number of CPBDs are wrong about the meaning of their own CS paradigms on light. The graphical representation in the BBC video of the bending of the laser beam in the room being accelerated upwards by a rocket motor (the representation at the left in the video) is even totally wrong when based on CS principles, as explained in Appendix II.

12.10.2.b A photon's "orbit" grazing the sun approach, on the basis of Newton's gravitation laws

The assumption needed here evidently is that Newton's gravity will bend a "star's ray of light" during a "grazing the sun" trajectory. Thus that the gravitational pull by the sun also works on light. It should be immediately remarked here that serious doubts arise regarding this assumption since it is already very hard to explain that a non-material "ray of light" has mass in some kind of way, in order to be attracted by the sun's gravity field. From a first light paradigm in CS, light being an electromagnetic wave, one would not agree that light as an electromagnetic wave shows a "mass". Then there is the second light paradigm in CS, namely the "particle" paradigm of light stating that light exists of photons, thus individual "particles", thus quanta.

Whatever the relevance or irrelevance, one needs to force mass upon a photon if one wants to continue with Newton's gravity to "be able to explain" a sun's gravitational bending of a "ray of starlight" grazing the sun. Nevertheless, one can find the Newton's gravity law based light bending by the sun explained in CS literature. The question of a photon "having mass or not" is thus clearly put in perspective here. One is thus faced here with that aspect of accepting a photon to show mass or not: one should then make a decision here to either continue reading this section 12.10.2.b or either to halt reading 12.10.2.b. In my opinion a photon has no mass and thus one should in fact not read further section 12.20.2.b. ...

However.., those who still want to learn more about the theoretical approach in the literature of the derivation/calculation of the bending when based on Newton's gravity can thus read further. One then needs to temporarily "accept" a photon to have a mass in order to have at least a theoretical look at the "gravitational attraction effect by the sun on a passing photon". Thus to temporarily accept a bending effect of the photon's trajectory in space, in the same way as an "orbit trajectory" of a material object corresponding to Newton's laws of gravitation. So,

- let's assume that the incoming "ray of light" comes from a star, thus originating from a very large distance
- when the photons in the "ray of light" are near the sun, the effect of the sun's gravity starts to increase and the bending towards the celestial body thus also increases up to the nearest point to the celestial body
- regarding the arrival at the nearest point to the celestial body we moreover assume that the light just grazes the celestial body. The "ray of light" thus has finished at that grazing moment just half of its bending trajectory. Obviously one expects the second half of the bending trajectory to be symmetrical and thus to be a mirror image of the first part of the bending trajectory.
- the very high velocity of light is much higher than the escape velocity and that causes the "ray of light" to continue its trajectory into the far space. Since light has a very high velocity it is also obvious that its total trajectory would be a hyperbolic "orbit".

One can then apply the known equations regarding a hyperbolic trajectory:
http://en.wikibooks.org/wiki/Astrodynamics/Orbit_Basics

A hyperbolic trajectory involves a conic section according to the equation in polar coordinates:

$$r = \frac{p}{1 + e \cdot \cos\vartheta} \qquad (12.10.5)$$

r = radius
θ = angle
p = parameter (a measure of the size of the conic section ; larger p = larger orbit)
e = eccentricity of the orbit

$$p = \frac{h^2}{\mu} \qquad (12.10.6)$$

p is determined by:
h = angular moment per unit mass of the particle in orbit
μ = standard gravitational parameter (μ = G.M)
(http://en.wikipedia.org/wiki/Standard_gravitational_parameter)
G = gravitational constant (6.67384E-11 m³.kg^{-1}.sec^{-2} which is the same as N.m².kg^{-2})
M = mass of the sun

According to http://en.wikibooks.org/wiki/Astrodynamics/Orbit_Basics one obtains an equation linking the velocity "v" of a particle in orbit and the value of "a" which is the semi-major axis of the orbit's hyperbola.

$$\frac{v^2}{2} - \frac{\mu}{r} = -\frac{\mu}{2 \cdot a} \qquad (12.10.10)$$

One obtains from this equation the following equation expressing "a", while replacing "μ" with G.M while having v=c:

$$a = \frac{1}{\frac{2}{r} - \frac{c^2}{G \cdot M}} \qquad (12.10.11)$$

The value of "a" is needed in the next equations in order to calculate the eccentricity "e" value.

When implementing:
r_{sun}=the sun's radius = 6.955E08 m
M = the sun's mass = 1.98855E30 kg

one obtains a = 1474.59 m

That value of "a" already gives a good idea of the extremely small bending of a "ray of light grazing the sun" that can be expected in the next calculations. Indeed, "a" is the value of the semi-major axis of the orbit's hyperbola: that means that the distance between the grazing point and the intersection of the two asymptotes above that grazing point is only about 1.5 km which, when compared to the vast radius of the sun being 6.955E05 km, is only 0.0002 % (!) of that radius. In the next calculations one then indeed will find the value of the extremely small deviation of the actual hyperbolic trajectory from a straight line.

At http://en.wikibooks.org/wiki/Astrodynamics/Orbit_Basics one also find:

$$p = a \cdot \left(1 - e^2\right) \qquad (12.10.12)$$

Therefore, when combining both equations by eliminating "p" (while replacing "μ" with G.M) one obtains an expression for "e":

$$e = \sqrt{1 - \frac{h^2}{a \cdot G \cdot M}} \qquad (12.10.13)$$

Since the value of "a" was calculated one can now calculate the value of "e" when having the value of the angular momentum of the "ray of light". It can be asked again here:

- if light has no mass: then there is no angular momentum? When one is convinced that a photon has no mass then indeed this all ends here.

- if light would have mass: how to determine the value of h? What does angular moment "h" mean here? See e.g. http://en.wikipedia.org/wiki/Angular_momentum and http://en.wikipedia.org/wiki/Orbit. The angular moment "h" is per unit mass and therefore the exact total mass of the particle does not interfere with the value of "h". Therefore its value is the multiplication of its velocity (c) with the distance to the midpoint of the sun, which in this case the radius of the sun since the "ray of light" is grazing the sun:

$$h = r_{sun} \cdot c \qquad (12.10.14)$$

Thus the equation for the eccentricity "e" then becomes:

$$e = \sqrt{1 - \frac{h^2}{a \cdot G \cdot M}} = \sqrt{1 - \frac{(r_{sun} \cdot c)^2}{a \cdot G \cdot M}} \qquad (12.10.15)$$

When implementing the equation for "a" in this equation one obtains:

$$e = \sqrt{1 - \frac{(r_{sun} \cdot c)^2}{\frac{1}{\frac{2}{r_{sun}} - \frac{c^2}{G \cdot M}} \cdot G \cdot M}} = \sqrt{1 - \frac{r_{sun}^2 \cdot c^2}{G \cdot M} \cdot (\frac{2}{r_{sun}} - \frac{c^2}{G \cdot M})} \qquad (12.10.16)$$

$$e = \sqrt{(\frac{r_{sun} \cdot c^2}{G \cdot M})^2 - 2 \cdot \frac{r_{sun} \cdot c^2}{G \cdot M} + 1} = \sqrt{\left(\frac{r_{sun} \cdot c^2}{G \cdot M} - 1\right)^2} \qquad (12.10.17)$$

Thus:

$$e = \frac{r_{sun} \cdot c^2}{G \cdot M} - 1 \qquad (12.10.18)$$

The value for the eccentricity "e" in this case of light grazing the sun thus is e=471657. Obviously, one notices that the subtraction of "1" has a very small effect on the value of "e", thus here one can simplify the equation of "e" into:

$$e = \frac{r_{sun} \cdot c^2}{G \cdot M} \qquad (12.10.19)$$

thus

$$\frac{1}{e} = \frac{G \cdot M}{r_{sun} \cdot c^2} \qquad (12.10.20)$$

In this case, the value of 1/e = 0.00000212 which is evidently very small.

According to http://en.wikipedia.org/wiki/Hyperbolic_trajectory: "*let the angle between approach and departure (between asymptotes) be 2θ*". The equation linking the eccentricity "e" and "θ" then is:

$$\theta = \cos^{-1}(\frac{1}{e}) \qquad (12.10.21)$$

or

$$e = \frac{1}{\cos\theta} \qquad (12.10.22)$$

As one immediately notices: since 1/e is that small and very near to zero that means that θ is very near to π/2 (thus is 2θ very near to π; thus is the trajectory very near to a straight line).

The very small total bending angle α that one is thus looking for is:

$$\alpha = \pi - 2 \cdot \Theta = \pi - 2 \cdot \arccos\left(\frac{G \cdot M}{r_{sun} \cdot c^2}\right) =$$

$$\pi - 2 \cdot \left(\frac{\pi}{2} - \arcsin\left(\frac{G \cdot M}{r_{sun} \cdot c^2}\right)\right) = 2 \cdot \arcsin\left(\frac{G \cdot M}{r_{sun} \cdot c^2}\right) \qquad (12.10.23)$$

When implementing G, M, r and c, the value of α in radians then becomes:
α = **4.240359304**10095 E-06 (12.10.24a)

That many digits are used in (12.10.24a) in order to make a comparison with the result from (12.10.24b) ; indeed remark the value of:
$2.G.M/r_{sun}.c^2$ = **4.240359304**09777 E-06 (12.10.24b)

The small difference between both values is simply caused by the fact that at very small values for an angle β the value of arcsin(β)≈ β ; thus:
$\arcsin(G.M/r_{sun}.c^2) \approx G.M/rsun.c^2$

Therefore, in principle, one can also write the approximation:

$$\alpha \approx 2 \cdot \frac{G \cdot M}{r_{sun} \cdot c^2} \qquad (12.10.25)$$

The extremely small value α = 4.24035930410095E-06 (radians) then becomes in arc seconds:
α = 0.875 arc seconds

There one has the calculated theoretical bending angle ...

12.10.2.c An Euler method based approximation of the hyperbolic orbit, as can be conveniently calculated, even in Excel

In the preceding section classic orbit equations were used to calculate the hyperbolic trajectory of a photon on an orbit grazing the sun, while assuming in particular that the photon has mass and thus is attracted by the sun's gravity. The photon's trajectory is then not a perfect straight line but is a very slightly bended trajectory: the incoming and outgoing parts of the trajectory show asymptotes under an angle of only 0.875 arc seconds!

It is perhaps interesting for one to know that it is possible to also simulate that trajectory by using the Euler method and even perform oneself the calculations in Excel. Such is explained further.

Consider the sun's centre as the (0,0) in a (x,y) frame. Consider also a photon departing in (0, r_{sun}) at the speed of light perfectly horizontal, thus in the direction perpendicular to the y-axis. One is still forced to assume that the photon has mass in order for the sun to pull the photon, in a direction toward the sun's centre. How can one now calculate the trajectory that the photon will travel under that assumed gravitational pull? So, what is the trajectory traj(x,y)=f(t) ?

The pulling force vector can be split in a horizontal vector component and a vertical vector component. Since light is that fast, let's assume that the horizontal pull effect from the sun can be neglected (please note that you moreover would run into a paradox if one would demand a horizontal pull effect to be implemented in the analysis since then one would end up with the photon showing a velocity which is not constant any longer!). As an indication of the "validity" of the assumption: the sun's radius r_{sun} = 6.955E08 m while the speed of light is 3E08 m/sec. That means that in e.g. about 60 seconds a photon travels a distance of about 25 times the sun's radius. The photon thus will escape rather quickly the influence of the sun's gravity effect: the pulling force is inversely proportional to the square of the distance between the sun's centre and the photon; so the pulling force goes down rather quickly with distance; when taking the suns' radius as a reference, the sun's gravity effect will thus already be about 25x25=626 times smaller after only 60 seconds!

So, according to the assumption one can calculate the horizontal x-part of the displacement of the photon according to:

$$x_{t+\Delta t} = x_t + \Delta x = x_t + c \cdot \Delta t \qquad (12.10.26)$$

Since c is taken constant, that is course equal to the following equation:

$$x_t = c \cdot \Delta t \qquad (12.10.27)$$

So one can use this equation to calculate, in e.g. Excel, the values of x(t). Since one wants to apply the Euler method and Newton's gravity law (see equation (12.10.28)) to calculate the position of the photon traj(x,y)=f(t) one needs to take a time step Δt which is small enough. Therefore one e.g. will use small time steps Δt=0.01 sec. The value of time resides in the Excel sheet in column #1, starting at t=0, with increments of 0.01 sec. Info: the simulation showed that a time value of 12.5 seconds was sufficient to obtain the final bending value very near 0.875 arc seconds. In the column #2 the value of x is calculated from equation (12.10.27). So, the values of x within the photon's position traj(x,y)=f(t) are present in column #2.

Then one has to calculate the y-values within the photon's position traj(x,y)=f(t). The value of y is the main effect since the vertical component of the pulling force of the sun is the major contributor in the deflection of the photon from its otherwise straight trajectory. The pull of the sun creates an acceleration towards the centre of the sun. That pull is of course depending from the distance "r" between the centre of the sun and the position traj(x,y)=f(t) of the photon. That is expressed in the following equation:

$$g_r = \frac{G \cdot M_{sun}}{r^2} = \frac{G \cdot M_{sun}}{x^2 + y^2} \qquad (12.10.28)$$

Within the Euler method approximation one further makes the assumption that during the Δt=0.01 sec time step linked to the movement of the photon of one position traj (x,y)=f(t) to the next position (x+Δx,y+Δy)=f(t+Δt) the value of g_r is constant. We can calculate Δy by calculating first the vertical component of g_r:

$$g_y = g_r \cdot \sin(\vartheta) \qquad (12.10.29)$$

Notice that the Cartesian coordinate system (x,y) is linked to the polar coordinate system (r, ϑ). The value of ϑ can be obtained from the value of the photon's momentarily position (x,y):

$$\vartheta(t) = \arctan(\frac{y(t)}{x(t)}) \qquad (12.10.30)$$

The value of ϑ is stored in a column.

[Remark: in order to not run into a "division by zero" problem (see further) within the very first calculation step when determining ϑ at t=0 a value it is necessary to simply use any very small value for the first value of $x_{t=0}$ in the column of x ; e.g. $x_{t=0}$ = 0.0001 m.]

The value for g_y then becomes:

$$g_y = \frac{G \cdot M_{sun}}{x^2 + y^2} \cdot \sin(\vartheta) \qquad (12.10.31)$$

The values g_y are stored in a column.

Since one assumed that the gravity in the photon's location traj (x,y)=f(t) at each time instance is locally constant one can also calculate the vertical component of the "free falling" photon velocity (one must have realized in the mean time here that it is all about a material's "free fall" which causes the trajectory and thus the hyperbolic one in this case). So we can also apply the classic equation for the velocity component v_y:

$$\Delta v_y = g_y(x, y) \cdot \Delta t \qquad (12.10.32)$$

Since v_y = 0 at t=0 one can calculate $v_y(x,y)$= $v_y(t)$ at each time instance by applying Euler's approach, thus by adding Δv_y to the previous value $v_y(t)$ in order to obtain the next local value $v_y(t+\Delta t)$. In that way the accumulating values for $v_y(t)$ are obtained. The calculated values of v_y are stored within a column.

Thus, finally, it is possible to calculate y by using Euler's method (while starting a t=0 with $y=r_{sun}$):

$$y_{t+\Delta t} = y_t + \Delta y \qquad (12.10.33)$$

while having locally:

$$\Delta y = g_y(t) \cdot \frac{\Delta t^2}{2} + v_y(t) \cdot \Delta t \qquad (12.10.34)$$

As a result, the Euler method simulates the values for x and y of the photon's trajectory traj(x,y)=f(t).

From the graphical representation (Figure 12.9) of the simulated hyperbolic trajectory the bending angle can be determined by drawing an asymptote (dotted line) to the hyperbole. Of course the vast (needed) difference in scale should be noticed for the x- and y-axis's in Figure 12.9 enabling one to at least get a visual idea of the (otherwise not noticeable, in the case of equal axis scales) bending. The angle between the asymptote then is determined from the asymptote's inclination (from determining the coordinates of the two intersection points of a linear asymptote with the x-axis and the y-axis). This resulted in:

$$\alpha = \arctan(\frac{6.955013E08 - 6.95493000E08}{3.92500000E09})$$

$$\alpha = 2.11464968E\text{-}06 \text{ radians} \qquad (12.10.35)$$

So:
α=2.1146E-06 radians = 1.2116E-04 degrees = 0.436 arc seconds

Thus:
2α=0.872 arc seconds

The Euler method, applied within Excel, thus approximates very well the result of 0.875 arc seconds as obtained in 12.10.2.b.

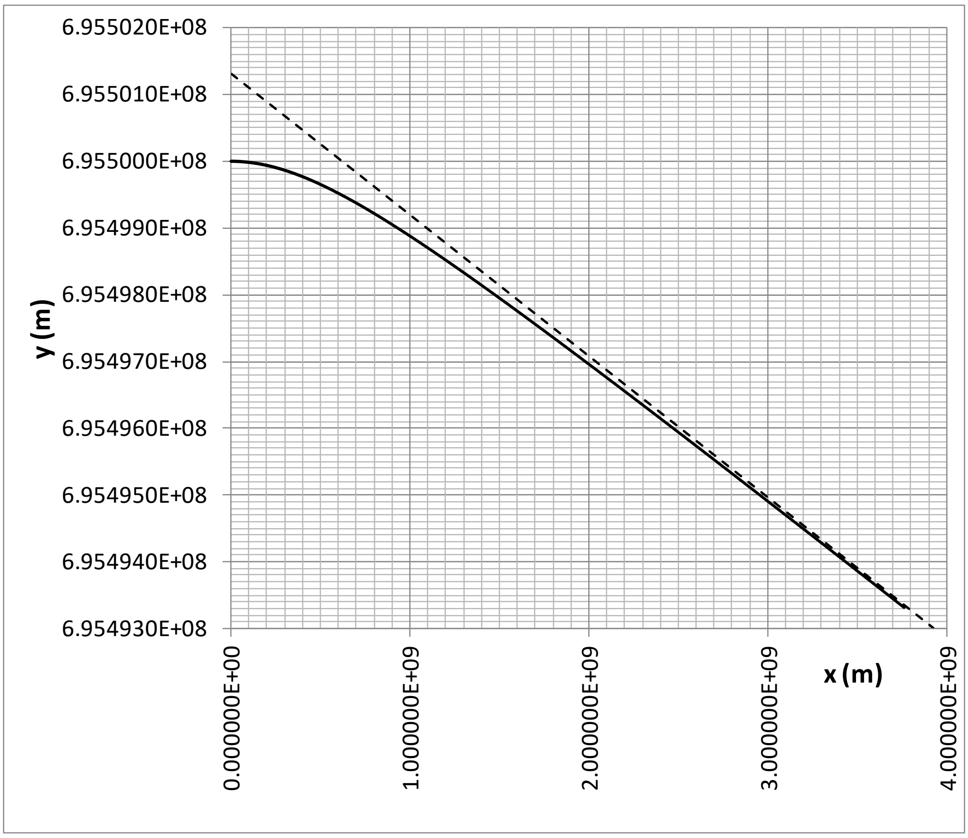


Figure 12.9 Simulation on the basis of the Euler approach

12.10.2.d Einstein's first approach in a 1911 publication in "Annalen der Physik"
Einstein's paper "*Einfluss der Schwerkraft auf die Ausbreitung des Lichtes*" ("*On the influence of gravitation on the propagation of light*") can be downloaded at e.g.:
http://www.physik.uni-augsburg.de/annalen/history/einstein-papers/1911_35_898-908.pdf

Please note that Einstein published this paper in 1911, thus 6 years later than his relativity paper in 1905. On page 906 Einstein introduces an equation (indicated as equation (3) in his paper) while he states for that equation "*Nennen wir c_0 die Lichtgeschwindigkeit im Koordinatenanfangspunkt, so wird daher die Lichtgeschwindigkeit c in einer Orte vom Gravitationspotential Θ durch dieser Beziehung*" ("*When we consider c_0 as the speed of light in the origin of the reference frame, then the speed of light c in a location within the gravitational potential field Θ is given by this equation*":

$$c = c_0 \cdot (1 + \frac{\Theta}{c^2}) \qquad (12.10.36)$$

The equation can also be written as:

$$c = c_0 + c_0 \cdot \frac{\Theta}{c^2} \qquad (12.10.37)$$

In those equations Einstein states that c is not a constant but in equation (12.10.37) at the left the "c" is then intended to be a variable while at the right side the very same "c" in the denominator of Θ/c² is seemingly intended to be a constant... ?

In section 4 (page 906 of his paper) he then describes the bending of light in a gravitational field Θ : *"§4. Krümmung der Lichtstralen im Gravitationsfeld*" ("*Bending of a ray of light in a gravitational field*"). Einstein is not using the concept of a photon nor the electromagnetic wave concept being described by the Maxwell equations. Einstein introduces a Huygens light wave front type of description. He then writes equation (page 907 of his paper):

$$\frac{(c_1 - c_2) \cdot dt}{1} = -\frac{\partial c}{\partial n'} \cdot dt \qquad (12.10.38)$$

He writes explicitly with respect to his Figure 2 on page 907 of his publication "*Die enstprechende Ebene gleicher Phase bzw. deren Schnitt mit der Papierebene, zur Zeit t+dt erhalten wir, indem wir die Punkte P_1 und P_2 mit den Radien c_1.dt bzw. c_2.dt Kreise und an diese die Tangente lege,* ***wobei c_1 bzw. c_2 die Lichtgeschwindigkeit in den Punkten P_1 bzw. P_2 bedeutet***". The text in bold means "*whereby c_1 and c_2 represent the speed of light in respectively P_1 and P_2*" where Einstein considers different values for the speed of light in the spatial points P_1 and P_2.

He then writes "*Der Krümmungswinkel pro Wegeinheit des Lichtstrahles is also*" (meaning: "*The angle of bending per unit of travelling distance of the ray of light is thus*"):

$$-\frac{1}{c^2} \cdot \frac{\partial \Theta}{\partial n'} \qquad (12.10.39)$$

He then is going to integrate over the total trajectory of the ray of light and writes (equation (4) on page 907 of his paper):

$$\alpha = -\frac{1}{c^2} \cdot \int \frac{\partial \Theta}{\partial n'} \cdot ds \qquad (12.10.40)$$

This is a peculiar and confusing step since Einstein indicates in equation (12.10.36) "c" not to be constant but then puts 1/c² outside the integral as a constant. Anyhow, Einstein arrives through the integration according to his equation and the Figure 3 mentioned on page 908 of his paper, to an expression regarding the total bending angle:

$$\alpha = \frac{1}{c^2} \cdot \int_{-\pi/2}^{\pi/2} \frac{k \cdot M}{r^2} \cdot \cos\vartheta \cdot ds \qquad (12.10.41)$$

One can also write:

$$\alpha = \frac{k \cdot M}{c^2} \cdot \int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot ds \qquad (12.10.42)$$

k is identical to G (gravitational constant)
M = mass of the sun

$\Delta = r_{sun}$ = radius of the sun
r and ϑ are the polar coordinates of a spatial point on the trajectory "s"

Einstein did not include the full integration in his paper but it is interesting to do this here since it shows that Einstein in fact used a simple mathematical approach in his modelling on the basis of his simple graphical representation in Figure 12.10. Indeed, nonetheless the fact that Einstein is solving a problem concerning a non-linear orbit/trajectory he simply uses a perfectly straight line to represent that bended trajectory. Einstein thus aims at modelling a bended curve while presenting it with a straight line and performing the integration along a perfect straight line to calculate the bending of the straight line... Such can, at least, being called peculiar. To prove that he did so: here is the complete integration procedure that he must have used.

Figure 12.10 is clearly presenting the polar coordinates approach of a perfect straight line:
$s = r \cdot \sin\theta$ (12.10.43)

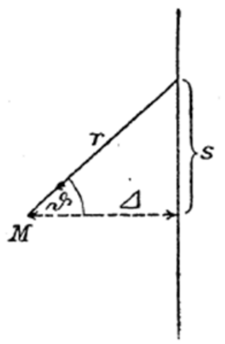


Fig. 3.

Figure 12.10 The figure 3 on page 908 in Einstein's 1911 publication

On the basis of equation (12.10.43) one wants to perform the integration in equation (12.10.42) and so one can write in that respect:

$$\frac{ds}{d\theta} = \sin\theta \cdot \frac{dr}{d\theta} + r \cdot \frac{d\sin\theta}{d\theta} = \sin\theta \cdot \frac{dr}{d\theta} + r \cdot \cos\theta \quad (12.10.44)$$

Since, **from the perfect line in Figure 12.10 as assumed by Einstein with Δ being constant**, one has:

$$r = \frac{\Delta}{\cos\theta} \quad (12.10.45)$$

Since Einstein assumes Δ to be a constant in equation (12.10.45) one then can write:

$$\frac{dr}{d\theta} = \Delta \cdot \frac{d}{d\theta}\left(\frac{1}{\cos\theta}\right) = \Delta \cdot \frac{\sin\theta}{\cos^2\theta} \quad (12.10.46)$$

One implements (12.10.46) in (12.10.44) to obtain:

$$\frac{ds}{d\theta} = \Delta \cdot \sin\theta \cdot \frac{\sin\theta}{\cos^2\theta} + r \cdot \cos\theta = \Delta \cdot \frac{\sin^2\theta}{\cos^2\theta} + r \cdot \cos\theta \quad (12.10.47)$$

So:

$$ds = (\Delta \cdot \frac{\sin^2\theta}{\cos^2\theta} + r \cdot \cos\theta) \cdot d\theta \qquad (12.10.48)$$

Within equation (12.10.42) one needs to perform the integration:

$$\int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot ds \qquad (12.10.49)$$

So one implements equation (12.10.48) in equation (12.10.49):

$$\int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot ds = \int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot (\Delta \cdot \frac{\sin^2\theta}{\cos^2\theta} + r \cdot \cos\theta) \cdot d\theta \qquad (12.10.50)$$

One also has:

$$\sin^2\theta = 1 - \cos^2\theta \qquad (12.10.51)$$

One then implements equations (12.10.45) and (12.10.51) in equation (12.10.50):

$$\int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot ds = \int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{\frac{\Delta^2}{\cos^2\theta}} \cdot (\Delta \cdot \frac{(1-\cos^2\theta)}{\cos^2\theta} + \Delta) \cdot d\theta \qquad (12.10.52)$$

Thus:

$$\int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot ds = \int_{-\pi/2}^{\pi/2} \frac{\cos^3\vartheta}{\Delta} \cdot (\frac{(1-\cos^2\theta)}{\cos^2\theta} + 1) \cdot d\theta \qquad (12.10.53)$$

Thus:

$$\int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot ds = \int_{-\pi/2}^{\pi/2} \frac{\cos^3\vartheta}{\Delta} \cdot (\frac{1}{\cos^2\theta} - 1 + 1) \cdot d\theta \qquad (12.10.54)$$

Thus:

$$\int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot ds = \frac{1}{\Delta} \cdot \int_{-\pi/2}^{\pi/2} \cos\theta \cdot d\theta =$$

$$\frac{1}{\Delta} \cdot (\sin(+\frac{\pi}{2}) - \sin(-\frac{\pi}{2})) = \frac{1}{\Delta} \cdot (1-(-1)) = \frac{2}{\Delta} \qquad (12.10.55)$$

So, when implementing equation (12.10.55) in equation (12.10.42):

$$\alpha = \frac{k \cdot M}{c^2} \cdot \int_{-\pi/2}^{\pi/2} \frac{\cos\vartheta}{r^2} \cdot ds = \frac{2 \cdot k \cdot M}{c^2 \cdot \Delta} \qquad (12.10.56)$$

This derivation makes it indeed very clear that Einstein could only have obtained the result within equation (12.10.56), as he published in his 1911 paper, by assuming a perfect linear trajectory (<u>where Δ is constant !</u>) in order to be able to calculate the degree of "bending" but then again of a perfect straight line! See somewhat further the explanation of the "mathematical luck", as I call it, that Einstein had in the analysis presented in his paper.

The result of the integration for the sun bending a grazing ray of light is then:

$$\alpha = \frac{2 \cdot k \cdot M}{c^2 \cdot \Delta} = \frac{2 \cdot G \cdot M}{r_{sun} \cdot c^2} \qquad (12.10.57)$$

This is seemingly the very same result as in the exact hyperbolic orbit analysis in 20.10.2.b :

$$\alpha = 2 \cdot \arcsin(\frac{G \cdot M}{r_{sun} \cdot c^2}) \approx \frac{2 \cdot G \cdot M}{r_{sun} \cdot c^2} \qquad (12.10.58)$$

But Einstein only uses the complete straight line "s" and not the bended line itself to perform his integration whereas in the classic exact hyperbolic analysis the deviation from a perfect straight trajectory of course is embedded from the beginning in the analysis and therefore the hyperbolic equations are exact. Even when using the Euler approach as in 20.10.2.c that cumulative effect of the deviation from the straight line is embedded in the calculation. So that is probably the reason that the exact analysis ends up with a remaining arcsin() whereas that is not the case in Einstein's approach in his 1911 paper. But because of the arcsin of a small value is practically equal to the small value itself the arcsin() is allowed to "disappear" and thus the exact analysis result ends up with the same expression ...

For that reason Einstein was thus simply "mathematically lucky" regarding the end-result in his 1911 paper since otherwise his mathematical analysis would have been seriously flawed. Remember here also that in 20.10.2.b and 20.10.2.c the hypothesis was that the gravitational field has an effect on light and that Einstein uses in this 1911 publication in fact Newton's gravitational field equation $G.M/r^2$ as well and thus actually the pulling force, in a comparable way as in the hyperbolic orbit exact approach of a "material object" grazing the sun at the speed of light...

According to his calculation, Einstein thus first published in 1911 the value of <u>0.83 arc sec</u> (see page 908 of his paper) with respect to the bending of light grazing the sun. So nothing new : that value was thus the same as the one calculated on the basis of Newton's gravity. On page 908 he then writes "*Es wäre dringend zu wünschen, dass sich Astronomen der hier aufgerollten Frage annähmen ...Denn abgesehen von jeder Theorie muss man sich fragen, ob mit den heutigen Mitteln ein Einfluss der Gravitationsfelder aud die Ausbreitung des Lichtes sich konstatieren lässt.*" ("*It is highly recommended for astronomers to look into this ... the question should be raised <u>if it would be possible to verify the bending of light with **contemporary** measuring instruments</u>*"). So there is Einstein's suggestion/call to investigate if it would be possible to measure the (extremely tiny) effect of the bending of light but with the equipment and means available at that time. Einstein thus seemed to doubt (in fact with reason) the capacity/accuracy of the instruments in his time era to fulfill the job (otherwise he would simply have urged to perform the measurements).

Due to the extremely small angle of deflection needed to be detected accurately and on the basis of the information that one can find in scientific literature, it seems that the measurements resulting from Einstein's request with respect to the bending of light by the sun still remains uncertain and cloudy (see 12.10.3). <u>Therefore again my urgent call to repeat in a university or a research centre the straightforward laser experiment discussed in (1)/(3) and which clearly showed a severe anomaly in CS</u>. And in the case of such type of laser experiment it is not about measuring an effect which is extremely tiny such as the bending of "a ray of star light" by the sun. On the contrary: the measurement of the laser dot lateral deviation is of the order of 1 mm at a distance of 10 m. Such type of measurements are straightforward when using the contemporary available sophisticated instruments. The results and conclusions from the confirmation of the result as e.g. shown in MWF2 at the website will trigger profound paradigm shifts. When compared to the massive funds spending/spended in research on e.g. particle physics or e.g. the Gravity Probe B, the suggested type of laser experiment is moreover financially not very demanding. It is therefore very strange that up to this moment after many years (regarding MWF2) still so little response in the scientific world was/is triggered in that respect. One can read in section 13 of (1) about the numerous efforts/trials over the many years to open the discussion on the suggested straightforward type of laser experiment and, in that respect, about the tenacity of the CPBD's strategy to ignore/block the views within (1) and the website and to not re-perform such straightforward type of laser experiment. However, a breakthrough of the views in (1) will not only trigger paradigm shifts and the start of improved paradigms but also trigger industrial applications (surveying on earth or in space applications).

With respect to Einstein's second attempt to model the bending of light and during which he obtained the value of 1.75 arc seconds on the basis of general relativity one can find the information on his calculations on the internet or in the literature.

Appendix II

The peculiar CS views with respect to the bending of a ray of light on the basis of the equivalence principle is e.g. explained at (see the animation there):
http://www.einstein-online.info/spotlights/equivalence_light

CS claims that in the cabin in Figure A the downward action of gravitational forces (thus the gravitational acceleration of 9.8 m/sec²) causes the downward bending of the laser beam.

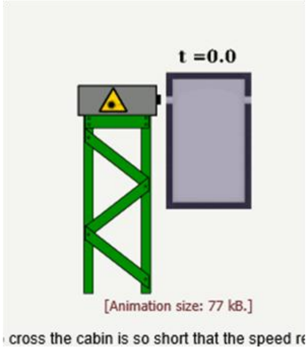
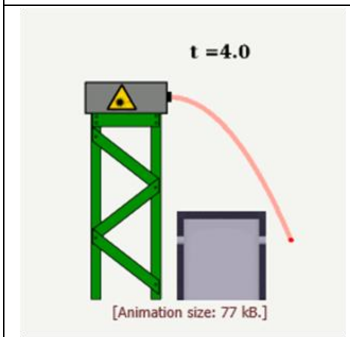
	As one can see : CS claims that the laser beam should enter the first opening and should always exit the second opening. The very simple CS reasoning behind such is that the laser beam always needs to be observed by an observer Obs_{ins} **inside** the cabin as going from the first opening in one horizontal straight line to the second opening. That is indeed the very simple reasoning within CS since CS **expects** the laser beam to behave as one straight beam ("linear ray of light" when observed by the observer in the cabin. According to CS the observer in the cabin thus does not observe a bended ray of light but a straight/linear ray of light (laser beam)! According to CS, the observer in the cabin will thus always see the laser beam to arrive at the fixed second opening. Only Obs_{ins} seems to have that CS privilege ..., thus exposing an "expectancy" reasoning of CS in the case of the many CS paradigms on light phenomena (see also the flawed model by Michelson and Morley, etc ... explained in (1)/(4) and the experimental counter-proof by a laser experiment (1)/(3) as demonstrated by MWF2). Any observer Obs_{out} **outside** the cabin: (see further ...)
	As a result CS claims that any observer Obs_{out} **outside** the cabin will observe: - the laser beam entering the first opening - but, since the cabin moves downwards (during the travelling time Δt_{travel} of light from the first opening to the second opening), - the laser beam **thus must bend** by gravity according to CS in order to exit the second opening of which the location has lowered due to the time interval Δt_{travel} !

Figure A The bending of light explained on the basis of the CS equivalence principle for light

The very simple CS explanation of the bending of a "ray of light" (laser beam) in a gravitational field is thus based on such type of CS thought experiment and the equivalence principle for light is thus also based on that very same type of CS thought experiment (see also the discussion in section 7 in (1) and also Figure 7.2 in (1)).

It is then also very interesting to watch the BBC video "***Watch this video to understand the biggest idea in physics***":
http://www.bbc.com/earth/story/20151118-watch-this-video-to-understand-the-biggest-idea-in-physics

However there is already a severe error at the left in the BBC video presentation in the case of the "rocket"-cabin undergoing an upward acceleration of 9.8 m/sec². The left hand part of Figure B represents that left hand part of the situation in the BBC video and thus should be based on the CS paradigms on light. It must in fact be very clear to any CPBD that the acceleration is in the upward direction as indicated and it must then also be very obvious to any CBPD that when performing a CS based thought experiment such as in Figure A on the very same CS basis of a first and a second opening in the cabin wall such will lead to the CS conclusion that the laser beam must be bended upward (not downward!) in the case of the "rocket"-cabin upward acceleration and as seen by <u>an observer outside the cabin</u>. According to CS principles, the representation in the right hand part of Figure B would then be the correct representation.

Moreover, according to CS principles, the observer in the cabin always needs to observe a straight laser beam otherwise the CS equivalence principle would be invalid ... Therefore the BBC video presentation is even representing the CS views in a totally incorrect way. It is thus very strange that no CPBD has reacted up to now in that respect ... Possibly as a result of a broader not understanding the CS basis of the CS thought experiment as presented in Figure A regarding the two openings as shown in Figure A?

However, it is explained in (1) that the CS equivalence principle for light/photons is totally flawed as demonstrated experimentally in MWF24 (website, (1) and (3)) and proven by the multiple inconsistencies and anomalies in the CS theories/views on light, as explained in (1), (2), (3), (4) and (5). Therefore Figure A is countered experimentally and theoretically. As well as the representation in Figure B (the left hand part of B is then double flawed; the right hand part of Figure B, being based on CS principles/paradigms, is then flawed in the very same way as Figure A).

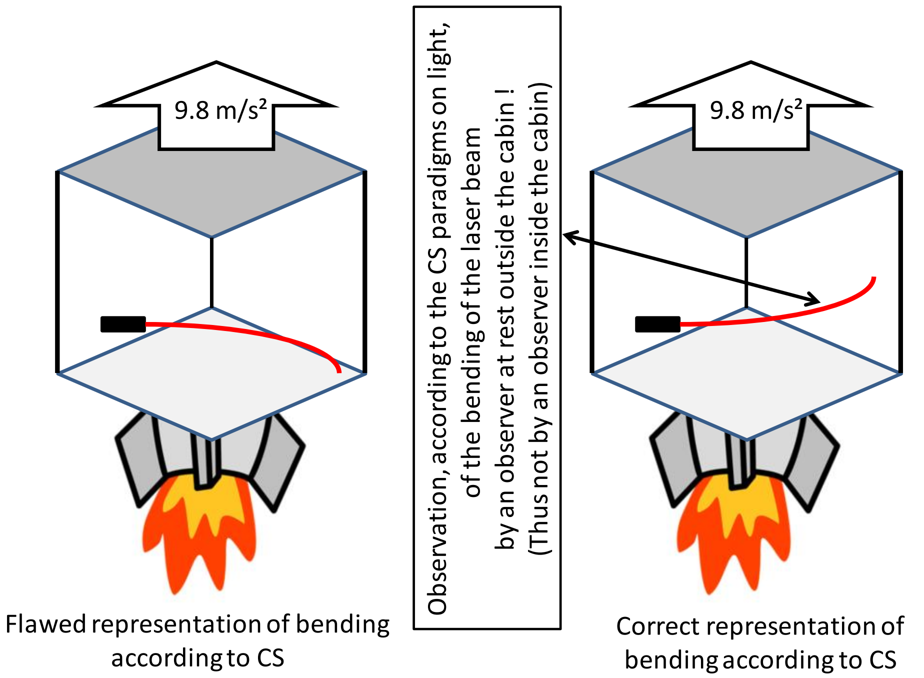


Figure B Representation of the left part (upward accelerated cabin) in the video from http://www.bbc.com/earth/story/20151118-watch-this-video-to-understand-the-biggest-idea-in-physics