Re: Bending of light not well authenticated

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- *From*: "Koobee Wublee" <kublai@xxxxxxx>
- *Date*: Sun, 22 May 2005 13:50:11 −0700

"Gene McGraw" <emcgraw@xxxxxxxxxx> wrote in message
news:429012f2.47002500@xxxxxxxxxxxxxxx
> On Sat, 21 May 2005 "Koobee Wublee" wrote:
>> I get the following two equations in accordance with most derivations
>> (r dH/dt)^2 / c^2 = (1 − 2 U)^2 b^2 / r^2
>> (dr/dt)^2 / c^2 = (1 − 2 U)^2 (1 − (1 − 2 U) b^2 / r^2)
>>Where H = angle of the photon where at perihelion H = 0
>> U = G M / c^2 / r, b = integration constant
>
> Those are indeed the equations of motion of a pulse of light (making
> allowances for your ambiguous notation of two divisions in a row).
> Hopefully you understand that those two equations are derived from the
> metric by the variational technique (corresponding to Fermat's
> Principle of Least Time), and they represent the set of light−like
> extremal paths. So the hard work is already finished by this point,
> and all that's left is to examine the path with the appropriate values
> of M and b to see how much deflection there is.
>
> If you really want to derive the deflection of light for general
> relativity, from scratch, you have to start with the field equations,
> derive the metric, and solve for the light−like paths to give the
> equations of motion that you cited above. From this point (which you
> seem to be taking as your starting point) it's fairly trivial to
> determine the deflection.

In the past couple of months, what you have mentioned is exactly what my point is. When I mentioned geodesic motion is none other than an event taken place with the principle of least action applied. Just like Fermat's derivation of Snell's Law, the least action means the least of time elapsed. Anyhow, I started with the spacetime equation with Schwarzschild metric. Using Euler−Lagrangian method just as Ciufolini/Wheelr did, I was able to arrive at the equations of motion for the two components of speed with the elapsed time minimized.

So, with the spacetimie equation using Schwarzschild metric identified below, we have

ds^2 = c^2 (1 − 2 U) dt^2 − dr^2 / (1 − 2 U) − r^2 dH^2

For a photon, we have

ds = 0

Thus,

c^2 (1 −2 U) dt^2 − dr^2 / (1 −2 U) − r^2 dH^2 = 0

By minimizing integral of dt, the equations of motion is history. For a refresher, they are

** (r dH/dt)^2 / c^2 = (1 − 2 U)^2 b^2 / r^2
** (dr/dt)^2 / c^2 = (1 − 2 U)^2 (1 − (1 − 2 U) b^2 / r^2)

However, these only represent half of the equations of motion which corresponds to what we observe. There is another half that is

ds^2 = c^2 dtau^2 − drho^2 − rho^2 dtheta^2 = 0

Again, applying the principle of least action, we get the following two equations of motion by minimizing the integral of dtau.

** (rho dtheta/dta)^2 / c^2 = b^2 / rho^2
** (drho/dtau)^2 / c^2 = 1 − b^2 / rho^2

These set of equations do not represent what are observed but what the photon behaves in proper spacetime. Notice there is no deflection of sort. Even when the photon are at a distance where rho = infinity. Since the boundary conditions must concur at (r = rho = infinity) where (U = 0). Why do you expect a deflect of the sort commonly misbelieved at (r = infinity at outbound) while the other set of equations of motion in proper spacetime tell you there is no anomaly at (rho = infinity)?

>> I have (b = R) where R is the perihelion of the photon to the sun
>> with mass of the sun = 0.
>
> The mass of the sun is not zero, it is M, and the value of the
> constant of integration b is not exactly equal to M, as can be seen
> immediately from your second equation of motion above. Remember, the
> perihelion distance R is, by definition, the distance from the path to
> the sun at the point on the path closest to the sun, and at this
> minimum point the derivative dr/dt is zero. Plug this into your second
> equation of motion above (with r = R to signify the perihelion
> distance) and solve for b. This gives b = R / sqrt(1 − 2U). Do you
> understand this?

You have failed to understand what I said. Let's try again. In flat spacetime where the sun is not there, but we can still identify a coordinate at the center of the sun if the sun is there. Using the Cartesian coordinate systen of (x, y), say a photon starts out its travel at (−oo, R) and will end its journey at (oo, R). If the sun were there, the center of the sun would be located at (0, 0).

Now, let's go back to our system where the sun has its center at (0, 0). This R is not the value of perihelion. At perihelion, the coordinate of the photon should be (0, R − dR). Therefore, we have

b = (R − dR) / sqrt(1 − 2 G M / c^2 / (R − dR))

This is in agreement with your equation of (b = R / sqrt(1 − 2 U)) if your R represents the value of periheilion which you have clearly specified, and I understand that. Since you have failed to realize dR plays a big role in the calculation of the deflection of the photon that I will show you, you have to abide by my definition for now. After all, at the end, you can equate (dR = 0).

So, continuing our discussion, the integration constant, b, can be matched in boundary conditions of the two pairs of equations of motion derived earlier. It is none other than R. Again, R, in my definition is not the perihelion. So,

b = R = (R − dR) / sqrt(1 − 2 G M / c^2 / (R − dR))

> There is no "dR" involved at this point [...]

On the contrary, we get

dR ~= G M / c^2

Notice how dR is proportional to M in the 1st order. As M increases, at certain value, the photo will be captured by a star with larger M.

> You're badly mistaken (again). The integration from r = infinity to R
> gives pi/2 + 2GM/(Rc^2), as does the integration from r = R to
> infinity, so the total deflection, accounting for both branches of
> the hyperbolic orbit, is 4GM/(Rc^2).

Now, we are ready to address the heart of this problem. So, after arriving at (dH/dr), the angle of deflection can be calculated by its integral. By integrating from infinity to (R − dR), if you don't know the value of dR, how can you arrive at the correct answer? In your language which you say R is the perihelion, if you don't know what R is, how can you arrive at a definite answer? You can only get an answer by approximating (dR = 0). In doing so, you have to prove the angle of deflection is much larger than (dR / R). Can you prove that?

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- ***Follow−Ups***:
  - ***Re: Bending of light not well authenticated***
    - *From:* Gene McGraw
- ***References***:
  - ***Re: Bending of light not well authenticated***
    - *From:* Randy M. Dumse
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    - *From:* ande452
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