Dmitri Krioukov (2012), *The proof of innocence,* arXiv:1204.0162

The article can be accessed at https://arxiv.org/abs/1204.0162 (you just need to click the PDF button in the download section). The paper is also available from the *Annals of Improbable Research* where you can find a whole host of other… interesting research.

You can also download the Cornell notes template for this paper (which includes the same questions) as a Word Document or PDF. Teachers, feel free to download this and forward it on to your students.

This week we're looking at a slightly more theoretical paper, but another paper where scientists show off their award winning sense of humour. We've discussed the arXiv in previous weeks, so this article has not gone through a thorough peer review. The reason for that, in this case, is that the author is not coming up with any new ideas, just using basic physics ideas to try and get out of paying a fine for a traffic violation in America.

We're also going to progress a little more with our notetaking. We won't provide any prompts during your reading, you can write these yourself. Do try and stick with the Cornell note style, even if its brief handwritten notes – we know some of you have been doing it by hand the whole time and it's how I prefer to note-take too. We're just going to give summary questions for each section. As this is a theory paper, you might want to alter your notetaking to thoroughly derive the equations as you go along and make sure they explain the physical scenario. I'll provide an example for how you might do this in section II.

To help this week, we have a series of tools that might be useful:

- We've made this applet to illustrate dynamically the two situations that the author describes. You can alter the acceleration of the car and the distance away the observer is to see (from the arrows) how the angular speed changes.
- You might want to use an online function plotter to try and plot some functions for yourself. Do email if you need any help.
- You also might want to check any integration and differentiation makes sense using an online tool.

With all of the tools above, don't rely on them to do the work for you. You should be able to attempt all of this plotting and calculus with pen and paper, but you should use them to check yourself.

I. INTRODUCTION

Why does a stationary observer not measure the speed of an object?	
What scenarios is the author going to consider?	

In the next section, the author will choose to use the point when the car is at the stop sign (when C is at S) as the origin of time – the point when $t = 0s$. Dealing with negative time is always a little confusing, but importantly for the argument running through this paper, all of the scenarios will be in some sense symmetrical about $t = 0s$. You can understand all of the maths by simply considering positive values for time (and this is sometimes beneficial).

II. CONSTANT LINEAR SPEED

This link gives an example of how I would take notes and convince myself of all the steps in the working out through a paper. I'm annotating all of the steps, clarifying *why* things are the way they are and filling in the intermediate steps to check the maths.
If you want to see proof that $\frac{d}{dt}\arctan(t) = \frac{1}{1+t^2}$ this link shows how you can derive it.

Why is equation (2) not technically correct?	
What are the benefits of the author choosing the time $t = 0s$ to be the point when the car meets the stop sign?	
What rule of differentiation does the author use in Equation (6)?	
Describe the graph shown in Figure 2. Link it to what is physically happening in the example of the car moving at a constant speed.	

III. CONSTANT LINEAR DECELERATION AND ACCELERATION

Remember, we have made this applet to help you visualise the difference in motion.

Explain the steps the author takes between equation (9) and (12) to prove the relationship given in equation (8)	

Using the explanation given after equation (12), can you derive the relationship given in equation (13)?	
Describe the graph shown in Figure 3. Link it to what is physically happening in the example of decelerating/accelerating car.	

IV. BRIEF OBSTRUCTION OF VIEW AROUND $t = 0s$

Remember, we have made this applet to help you visualise the difference in motion.

What are x_f and x_p?	
What is the biggest assumption made in this section?	
What is the time t'?	
What conclusion does the author draw from the fact that $t_p > t'$?	

V. CONCLUSION

Describe how the three bullet points in the conclusion link to Figure 5.	

APPENDIX 2: ARE THERE ANY FLAWS IN THIS ARGUMENT?

This question is going to be a challenge and set as an optional summary question. The author states that a “Yaris accelerates to 100 km/h in 15.7 s”, but claims that an acceleration of 10m/s^2 in the early stages may be justified. I have also seen that a Toyota Yaris moves from 50mph to 70mph in around 8s. BE CAREFUL WITH ALL THE DIFFERENT UNITS. Do you think it’s possible that an acceleration of 10m/s^2 is achievable for a Toyota Yaris, given the manufacturer’s data? HINT: Graphs.

SUMMARY QUESTIONS (submit these, along with your SKIM-READ answers to thomas.millichamp@warwick.ac.uk)

Explain why an object moving at a constant speed does not necessarily appear that way to an observer as it moves towards, past and then away from a stationary observer.

In a similar way to my notes for section II. Constant Linear Speed, send in your notes on how you arrived at the solution for section III. Constant Linear Deceleration And Acceleration. You can submit this as a photo of your hand-written notes if that's easier – however suits you best.

As budding physicists, do you think that this paper presents an adequate defence for the author's position that he did actually stop at the stop sign?

Optional summary question from the appendix.

FURTHER READING

This week, we don't have further reading tied to the topic, just a completely separate (and short) article from Physics Today entitled *Transportable clocks achieve atomic precision* about using portable atomic clocks to measure gravitational redshift. This is an excellent opportunity to practice writing your own skim-read and summary questions. Feel free to send in your work!