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Extreme Earth Events

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Background

- A fireball is another term for a very bright meteor, generally brighter than magnitude -4, which is about the same magnitude of the planet Venus in the morning or evening sky.

Interesting fact: Meteors enter our atmosphere everyday but mostly go unidentified.

- In this presentation I will be looking at the component velocities of a fireball and how they contribute toward the resultant velocity.

Significance of Research

1. **Trajectory Prediction**

2. **Blast Wave Impact**

3. **Fragmentation Risks**

4. **Sonic Boom Effects**

Overall understanding of the component velocities of a fireball provides a more nuanced picture of its potential impact on humans. It allows scientists to make more precise assessments of risks and take appropriate mitigation measures.

Research Question:

How do the vector velocities of a fireball contribute to the final velocity?

Hypothesis:

Component velocities contribute equally to the velocity of a fireball.

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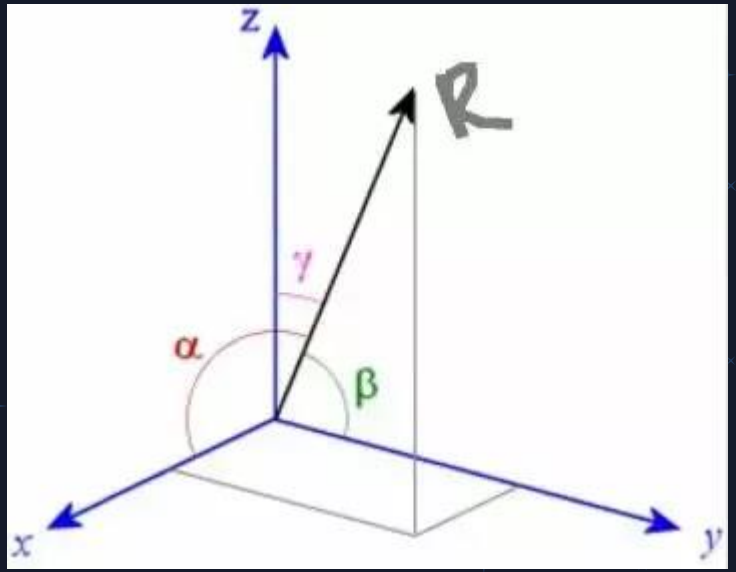
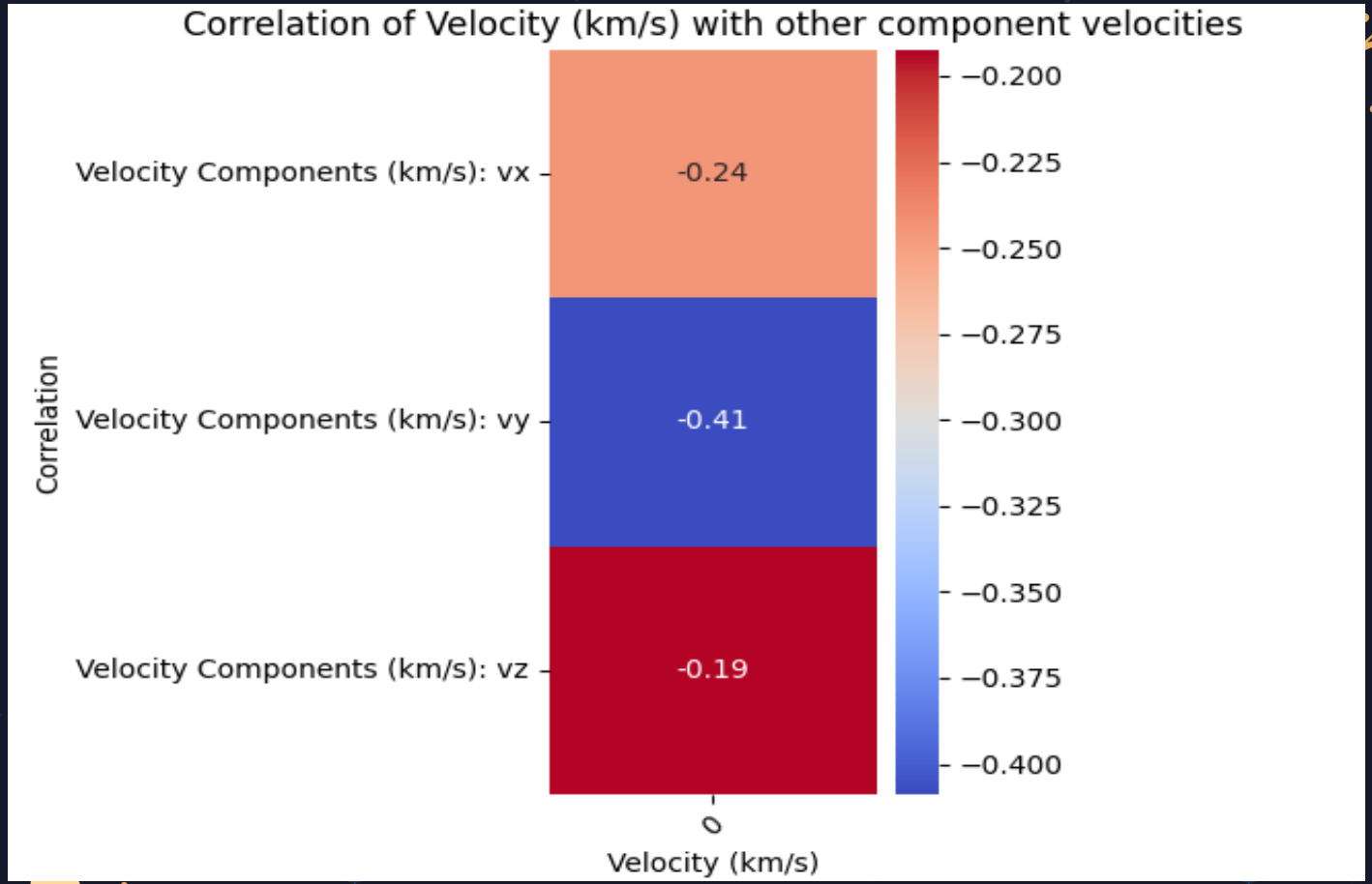
Methods

- I used a heatmap to show the correlation, r of the component velocities with the resultant velocity.
- For this problem I cleaned the data and I used scatter plots with linear regression to analyse the relationship between the component velocities and the resultant velocity. (using python)
- I also used a t-test and p-values to determine the significance of the relationship.



https://images.app.goo.gl/9Ctwg9wUeWzSu3JUA

Results


Correlation of Velocity (km/s) with other component velocities
Velocity Components (km/s): vx
Velocity Components (km/s): vy
Velocity Components (km/s): vz
-0.24
-0.41
-0.19
Correlation
−0.200
−0.225
−0.250
−0.275
−0.300
−0.325
−0.350
−0.375
−0.400
0
Velocity (km/s)

T-test/p-values (using vassarstats.com calculator)

Z-component

N =	91	r =	-0.19
Reset		Calculate	
t		df	
-1.826		89	

P		
	one-tailed	0.0356235
	two-tailed	0.071247

X-component

N =	91	r =	-0.24
Reset		Calculate	
t		df	
-2.332		89	

P		
	one-tailed	0.01097
	two-tailed	0.021940

y-component

N =	91	r =	-0.41
Reset		Calculate	
t		df	
-4.241		89	

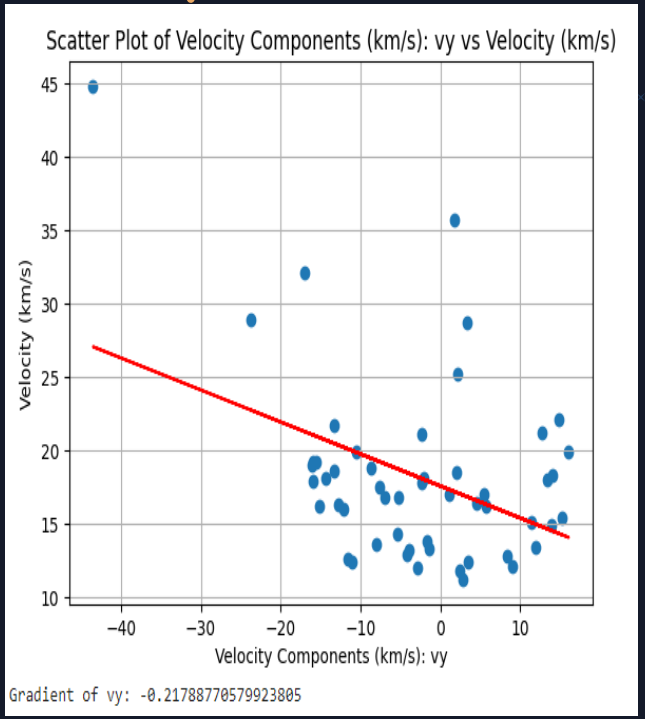
P		
	one-tailed	0.000027
	two-tailed	0.000054

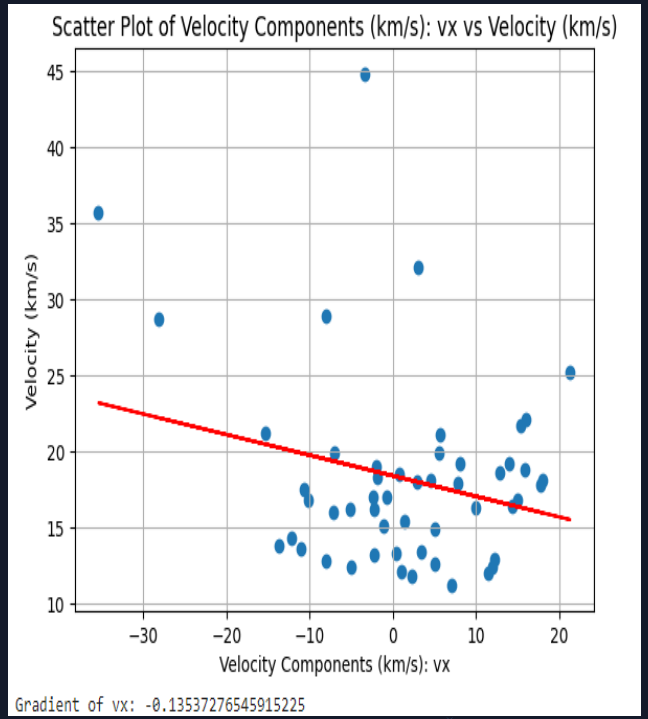
Key

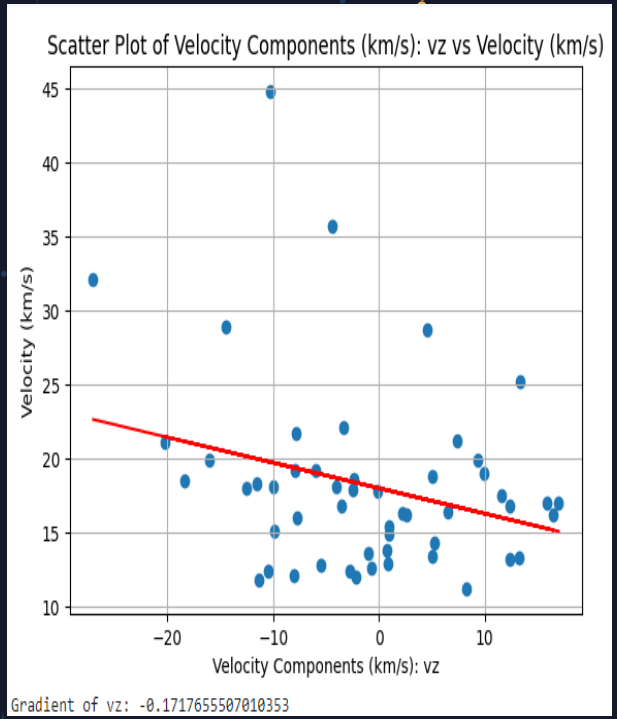
t : T-test value
df: degrees of freedom
P: p values
N: samples
r: correlation

Scatter Plot for each component velocity

*Some values of velocity(km/s) were missing and were calculated using the formula (x^2)+(y^2)+(z^2)







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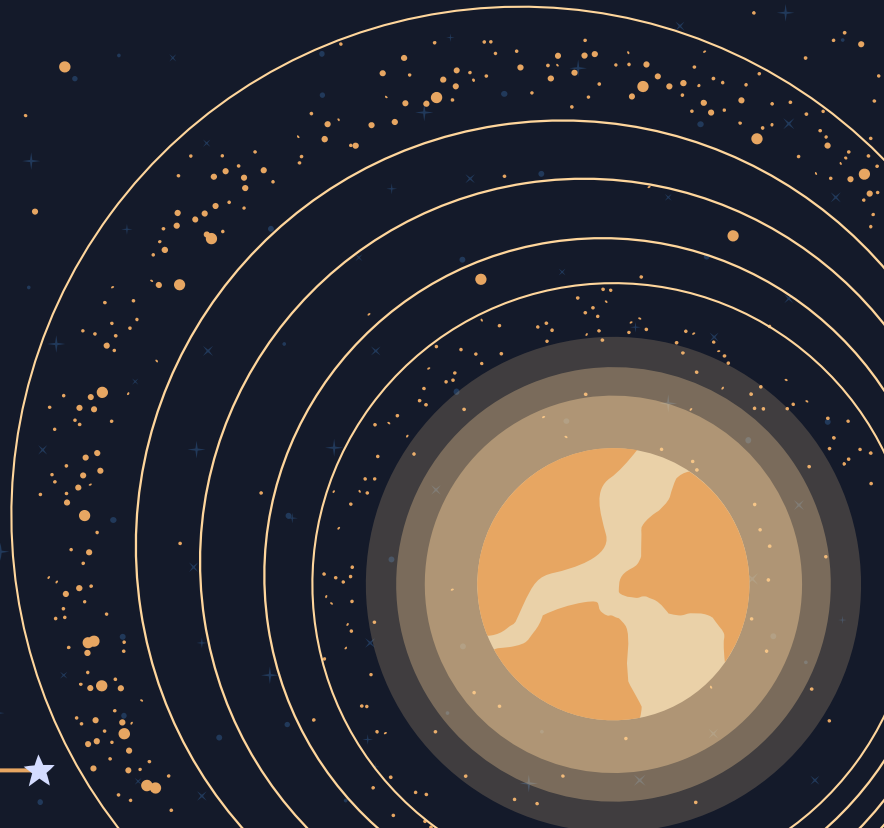
Conclusion

In conclusion my hypothesis was not supported, the results showed that the y-component has a greater relationship to the velocity compared to the other two component velocities and is likely to have a greater impact on the velocity.



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Future Studies

Considering the results it would be more reasonable for scientists to focus more on the y-component of the velocity since it has a more clear and significant relationship with the velocity.

References

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- *Cooke, B., Brown, P., Blaauw, R., Kingery, A., & Moser, D. (2015, April). When the Sky Falls: Performing Initial Assessments of Bright Atmospheric Events. In IAA Planetary Defense Conference (No. M15-4455).*
- *Image of vector forces, https://images.app.goo.gl/9Ctwg9wUeWzSu3JUA*
- *Gemini ai, https://g.co/gemini/share/bedc92453ea9*

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Thank you!

Do you have any questions?

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