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From Quarks to Cosmos

Simulation of a Transit Method for detection of Exoplanets

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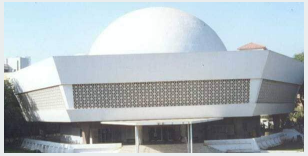

ABSTRACT

We present the simulation of a transit method for detection of exoplanets. Our aim is to explore the easier approach to teach this concept to Undergrad and advanced high schools students and also to give them hands-on experience. For simplicity, here we only consider one planet around the target star. We simulate the star-planet system using 'Vpython' and analyse it through 'Tracker' to produce lightcurves and the respective data file in terms of Time and Flux. Light Curves and the Data files are analysed by Tracker and Python algorithms. We then estimate the Radius of the exoplanet and orbital radius using observables such as transit depth, transit duration, and Orbital period. Finally, these values are compared with the input parameters of the Vpython simulation to calculate the errors and to state the conclusion.

Problems

- **How to teach Transit of Planets around stars in simplest possible manner?**
- **How can one visualize the transit method?**
- **Giving hands - on experience of data handling of a synthetic case which can be very helpful to understand real data.**
- **What are the Online Open source tools available?**

Results & Conclusion

CASE I

Softwares	Orbital Period (days)	Transit Depth	Transit Width	Radius of planet(Rp)	Orbital Radius ('a')	Theta (Deviation from 90) deg	Impact parameter
Visual Python simulation	6.50	-	-	6.0e9	7.70e10	-	-
Python	6.58	0.051	0.57	9.0e9	1.03e10	3.88	0.257
Tracker	6.62	0.089	0.90	1.2e10	1.03e10	1.15	0.870

CASE II

Softwares	Orbital Period (days)	Transit Depth	Transit Width	Radius of planet(Rp)	Orbital Radius ('a')	Theta (Deviation from 90) deg	Impact parameter
Visual Python simulation	6.80	-	-	1.0e10	7.70e10	-	-
Python	6.58	0.110	0.42	1.4e10	1.03e10	3.88	0.257
Tracker	6.61	0.210	1.02	1.9e10	1.038e10	1.82	0.550

CASE III

Softwares	Orbital Period (days)	Transit Depth	Transit Width	Radius of planet(Rp)	Orbital Radius ('a')	Theta (Deviation from 90) deg	Impact parameter
Visual Python simulation	4.06	-	-	6.0e9	7.70e10	-	-
Python	3.89	0.073	0.29	1.1e10	7.36e9	5.50	0.256
Tracker	3.92	0.089	0.587	1.2e10	7.36e9	1.64	0.610

Conclusion

We showed this method to few of the undergraduates and high school students. We found the second year undergraduates with basic python knowledge were able to follow the python programming approach on the other hand high school students found it confusing and difficult since they don't have a strong background of object-oriented programming. Both of them followed the Tracker method. We also saw that tracker software has a limitation for analysing star-planet system size. Hence these approaches could be enhanced by strong computation, better tracking softwares and combining more packages together to analyse the complicated datasets. This method is preliminary can can be further refined for more robust model by strong computation, better tracking softwares and combining more packages to analyse more complicated data sets.