A Computational Physics Study in Quantum Fluid Astrology

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Here we describe briefly what physics problem we have addressed and what the major results are. The abstract is usually the length of a medium-sized paragraph, and you should make it a cogent summary of the paper. Many people only read this far so make it good!

INTRODUCTION AND OVERVIEW

In recent years there has been a significant increase in interest in the study of ultra high energy cosmic rays (UHECR) with energies above 10^{19} eV. These subatomic particles, each with individual energies approaching that of a major-league fastball, are believed to be some type of matter of extragalactic origin, perhaps accelerated in the cores of distant quasars [3]. It was thought that there would be a dramatic decrease in their flux (number of particles/area/time) at energies above 10^{20} eV [1, 2]. However, recent evidence indicates that this decrease does not occur [4, 5]. This has been interpreted as indicating that the observed events are not due to primary high energy protons but rather to exotic new particles such as massive relic particles left over from the Big Bang [6].

DESCRIPTION OF COMPUTATIONAL PROBLEM

To address the physics issues introduced above, several computer algorithms have been explored. These are summarized in table I. The *Brute Force* algorithm just uses muscle to bulldoze your way through the problem regardless of efficiency. The *Finesse* algorithm involves some clever approach to the problem and is more efficient. Finally, the *Runge-Kutta* algorithm is by far the most efficient, since it is optimized for integration of ordinary differential equations.

There are many possible contributing factors to these statistics.

Contributing factors.

Contributing factors often add to the complexity of a problem. Some of the contributing factors, which are described within this subsection of the current section, are:

- first one thing
- then another
- then another one still
- and finally, the last one

TABLE I. *Computational algorithms explored.*

Name	*description*	*Efficiency*
Brute force	just mash your way through it	27%
Finesse	do something clever [6]	33%
Runge-Kutta	standard approximation [7]	40%

Factors within factors.

There are even factors that occur within other factors, and these are described within this subsubsection of the current subsection. This many levels of sectioning are usually not needed but can be useful sometimes.

RELEVANT EQUATIONS

Here are some equations that may or may not be relevant to the material above. The first equation shows how to use some inline mathematics, for which the $ character is used in latex to open and close the math mode. For example, you can describe the fact that there Avogadro's number can be written as $N_A = 6.022 \times 10^{23}$ atoms per mole, or that the ideal gas equation is $PV = NRT$, or that angular frequency can be written as $\omega = 2\pi f$.

If a full-blown numbered equation is needed, for example a Fourier transform, you would write:

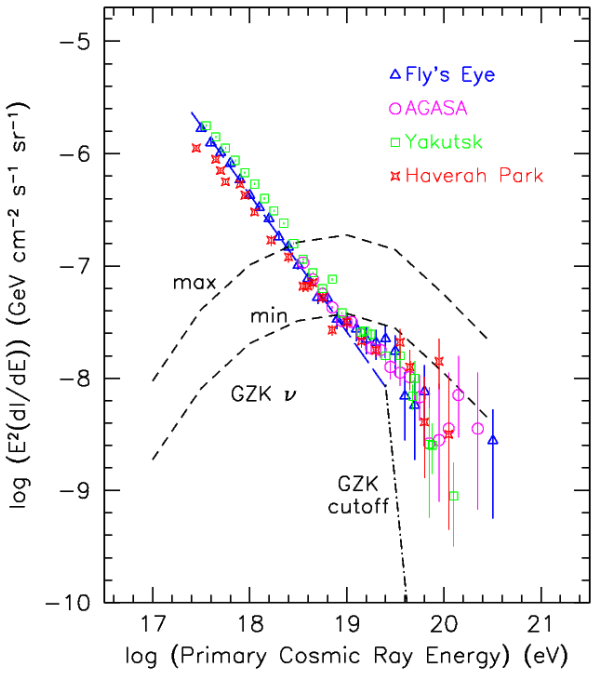

FIG. 1. *Cosmic ray fluxes at the highest energies.*

$$\tilde{F}(\omega) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} f(t) e^{-i\omega t} dt \qquad (1)$$

where ω is the radian frequency, $f(t)$ is the function in the time domain, and $\tilde{F}(\omega)$ is its complex Fourier transform partner in the frequency domain. We describe all of the terms since, as with any equation, we need to define these if they have not been introduced before.

RESULTS AND ANALYSIS

Here are some of the results of the analysis. Figure 1 shows a plot of something vs. something, indicating the results that we consider to be most important in this analysis. Of course in a real paper we would discuss in detail the features of this plot, but this is just a template.

You should also note that there are some special characters in latex, that you cannot use without modification. The \$ must be preceded by the backslash character, as must the & and the % characters, or they will mess up your compiling. If you are so foolish as to need the backslash character itself in your text....well I won't even go there.

DISCUSSION

This optional section is used to amplify some of the analysis of our results, and make inferences about what it might mean to the physics problems we are trying to address. This is a good place to compare our results to previous work, and maybe even synthesize some of our ideas about the work into general observations or conclusions, which are going to be restated in brief in the next and final section.

CONCLUSIONS

We conclude various important things, which we summarize in this section. Although we have probably stated all of them before this, we want to reinforce how we succeeded at reaching the goals of our paper, and what it all means for physics. Note that some people who are scanning your paper may jump to the conclusions to see if there is something that warrants their reading the paper in detail, so you should be sure to include salient stuff here.

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[1] K. Greisen, "End to the Cosmic Ray Spectrum?," *Phys. Rev Lett.* **16**,748 (1966).

[2] G.T. Zatsepin and V. A. Kuz'min, *JETP Letters* **4**, 78 (1966).

[3] K. Mannheim, R.J. Protheroe, J.P. Rachen *Phys. Rev. D* **63** (2001) 023003.

[4] see AGASA contributions to 27th ICRC, Hamburg 2001 (in press 2001); M. Takeda, *et. al.*, *Phys. Rev. Lett.* **81**, 1163 (1998); N. Hayashida, *et. al.*, *Astropart.Phys.* **10**, 303 (1999); N. Hayashida, *et. al.*, *Astrophys. J.* **522** 225 (1999).

[5] T.Abu-Zayyad, *at. al.*, "Measurement of the Cosmic Ray Energy Spectrum and Composition from 10^{17} to $10^{18.3}$ eV Using a Hybrid Fluorescence Technique", *Astrophys. J.* **557**, 686 (2001).

[6] G. Sigl, S. Lee, P. Bjhattacherjee, and S. Yoshida, *Phys. Rev. D* **59**,43504 (1999).

[7] N. Hayashida et al., "Possible Clustering of the Most Energetic Cosmic Rays Within a limited Space Angle Observed by the Akeno Giant Air Shower Array," *Phys. Rev. Lett.* **77**, 1000 (1996).