A Sample paper for Physics Education

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Abstract

A well composed abstract is a great asset. It informs in brief the key results of the study, clearly enunciating the assumptions used, principles and philosophy employed to arrive at the salient results. The length of the abstract is determined by the minimal length needed to give the reader a reasonable gist of the paper for him/her to decide whether (s)he should devote time for further study.

1 Introduction

Introduction must always be carefully written to bring out the distinct features of any contribution. It is widely known that most readers do not go beyond the first section. The author will be advised that he clearly expresses the new result advanced in the paper in the first few well chosen paragraphs. It should define the context, give underlying basis for investigation and clarify the methods that the author has undertaken. Here is one such example. Synchronization of chaotic systems has received much attention in the last decade since the work of Pecora and Carrol. This has been partly fuelled by potential applications of chaos control, synchronized dynamics in various areas ranging from secure communication, neural networks and pattern formation. Even though, at first sight, it appears that the sensitive dependence on initial conditions being the hallmark of chaos might preclude any synchronization from taking place, it has been amply demonstrated that synchronization of chaos is possible. Much of the work on chaos synchronization has focused on low dimensional maps and flows since they form the building blocks for complexity in physical systems. However, many spatiotemporal phenomena in nature are chaotic and at times display synchronization. One of the well known examples is the synchronized neuronal firings recorded by the

EEG devices. To understand such spatially extended systems coupled map lattice (CML) was introduced by Kaneko as a model for high dimensional chaos capable of displaying a variety of dynamical features including spatio-temporal chaos. The related question is the synchronization of spatio-temporal chaos in CMLs. The general strategy is to achieve synchronization by an appropriate feedback or drive mechanism. For instance, a generalization of Pecorra and Carrol method suggested by Kocarev and Parlitz, called active passive decomposition has been used to synchronize CMLs [1]. This is based on a general decomposition of any autonomous dynamical system by rewriting it formally as a nonautonomous system with a drive term. In this paper, we obtain delay synchronization in CMLs by applying the continuous feedback technique introduced by Pyragas. Earlier, this method had been applied with instantaneous coupling, i.e, without delay. Here, we apply the feedback with a delay, in order to mimic real-life processes where information takes finite time for transmission in a network, i.e, the transmission time is not negligible. Let us suppose that we have two CMLs, named as $X_{n+1}(i)$ and $Y_{n+1}(i)$, where n and i denote the time and space index respectively. In this method, a suitable form of the signal from X system is fed with a constant delay k at every instant into Y system. Under suitable conditions this leads to $X_{n+k}(i) = Y_{n+1}(i)$ synchronized state, even when X and Y individually continue to execute chaotic dynamics. The paper is organized as follows. With a brief discussion of the two important concepts in dimensional analysis, we directly use these concepts to some classic but not known problems in section 3. In section 4, we discuss the applications of DA to some quantum mechanical problems. Finally, we give our conclusions in last section.

2 Dimensional Analysis

The second section must be on the method employed and basic assumptions and limitations of the technique clearly enunciated. Dimensional analysis (DA) is one of the powerful tools in theoretical physics, often invoked to solve the problems without much mathematics. Dimensional analysis in physics has been routinely used to discuss the dependence of various physical quantities with others and for conversions of units from one system to others. Here, we would like to discuss some of the physical problems which can be tackled so nicely by this method. These problems are not often discussed in the text books or in the classrooms for the young students. The bottom line of the DA is that one does not solve the exact functional form of the solution to a given problem. There are some excellent review articles [1, 2] in the literature where some interesting problems have been discussed in detail.

The phenomenon of cold emission of light is known as luminescence. Scientifically, luminescence is the non-equilibrium phenomenon of excess emission over and above the thermal emission of a body, in which emission has a duration considerably exceeding the period of light oscillations (1-4). Although excess emission over and above the thermal background takes place in reflected and refracted light, Rayleigh and Raman scattering, and in Cerenknov and laser radiation, they are not the phenomenon of luminescence as the emission durations is these phenomena are of the order of the period of light oscillations. which is order of 10^{-14} to 10^{-15} s

If you need to introduce a long equation that stretches into two columns or a wide table you may want to be briefly in a full page width single column page layout for a portion like here. You may use by wrapping that part between \begin{widetext} and \end{widetext}, as shown here.

The binomial expansion is given by,

$$(x+a)^n = \sum_{k=1}^{n} C_k^n x^k a^{n-k}; \qquad C_k^n = \frac{n!}{k!n-k!} \tag{1}$$

$$|\psi(0)\rangle = \frac{1}{\sqrt{2}}|1\rangle + \frac{i}{\sqrt{2}}|2\rangle; \qquad |E_1\rangle = \frac{1}{\sqrt{2}}|1\rangle + \frac{1}{\sqrt{2}}|2\rangle \tag{2}$$

We get

$$\begin{aligned}
\langle E_1|\psi(0)\rangle &= \langle E_1| \left[\frac{|1\rangle + i|2\rangle}{\sqrt{2}}\right] \\
&= \left[\langle 1|\frac{1}{\sqrt{2}} + \langle 2|\frac{1}{\sqrt{2}}\right]\left[\frac{|1\rangle + i|2\rangle}{\sqrt{2}}\right] \\
&= \frac{1}{2}\left[\langle 1|1\rangle + \langle 2|1\rangle + i\langle 1|2\rangle + i\langle 2|2\rangle\right] \\
&= \frac{1}{2}\left[1+i\right]
\end{aligned} \tag{3}$$

We may then get back to two column format and continue with the text such as we are doing here. It is preferable to use the align environment instead of the eqnarray environment for multi-line equations.

Luminescence is related to the basic science as well as to the applied science industry and technology finds several applications in domestic appliances.

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Variable	Force	Energy	Pressure	Power	Viscosity
MKS units	Newtons	Joules	Pascals	Watts	Stokes
Dimension	MLT^{-2}	ML^2T^{-2}	$ML{-1}T^{-2}$	$ML^2T{-3}$	$L^2T{-1}$

Degeneracy pressure is a consequence of quantum statistics in extremely dense matter. Pauli exclusion principle (PEP) states that no two identical fermions can have the same state. Electrons, protons, neutrons, neutrinos, etc., being spin half particles, are fermions. According to PEP, in a gravitationally bound system like the iron-rich core of an evolved star, all the electrons cannot occupy the lowest energy level (unlike, what happens to identical bosons in Bose-Einstein condensates, e.g. He^{-4} superfluid). So, the energy levels are filled up with two electrons (one with spin up state and the other with spin down) per orbital, as demanded by the PEP. Hence, more the density of electrons, higher is the energy level that gets to be occupied.

Gravitational shrinking of such a dense core leads to an increase in electron density, thereby facing a resistance since the contraction implies putting electrons at higher energy levels. Therefore, in such a degenerate system, gravitational collapse instead of lowering the energy of the star tends to increase it. The resulting pressure against shrinking, arising out of PEP in such electron-rich dense matter is called electron degeneracy pressure (EDP). You may wish to introduce a figure with accompanying figure caption, when they can both fit in one column, like here. You may continue with

Figure 1: A view of the grains in the crops. Correlate this with Eq. (1) above. This is a JPG graphic.

further content of the paper:

A white dwarf is a star that exists in hydrostatic equilibrium not because of thermal pressure but due to the EDP that counteracts gravitational contraction. Fowler had assumed that electrons are moving non-relativistically inside the core and had shown that the EDP of a white dwarf is proportional to $\rho^{5/3}$, where ρ is the density of the core.

Chandra was unaware initially that Anderson in 1929 and Stoner in 1930 had independently applied special relativity to obtain mass limits for a degenerate, dense star of uniform density without taking into account the condition of hydrostatic equilibrium. Fowler pointed this out to him when Chandra reached Cambridge, and he added these references to his papers on relativistic degeneracy in white dwarf stars[3]. Landau too had arrived at a mass limit independently in 1931, which appeared in print one year later.

The Chandrasekhar mass limit implies that no white dwarf with mass greater than this limit can hold out against gravitational collapse. So far, all the white dwarfs discovered (e.g. Sirius B, the companion star to Sirius) in the cosmos, have mass less than M_{Ch}. For masses beyond this limit, two prescient ideas were put forward independently, that played important roles later - one of Landau, before the discovery of neutrons by Chadwick in 1932 and the other by Baade and Zwicky, after the discovery. Landau had speculated that for stellar cores whose mass exceeded M_{Ch}, the density would become so large due to shrinking that the atomic nuclei in the core would come in contact with each other - the whole core turning into a giant nucleus. Baade and Zwicky, while attributing the origin of cosmic rays to stellar explosions called supernovae, correctly identified the energy liberated due to sudden decrease in the gravitational potential energy (as the core collapses rapidly to form a neutron star of radius $\sim$ 10 km) as the one that powers supernova explosion.

3 Inclusion of Graphics

Graphics (figures/diagrams) can be included as image files in the PDF, JPG and PNG formats. Each type has its strengths and weaknesses and these must be looked into before choosing the file type.

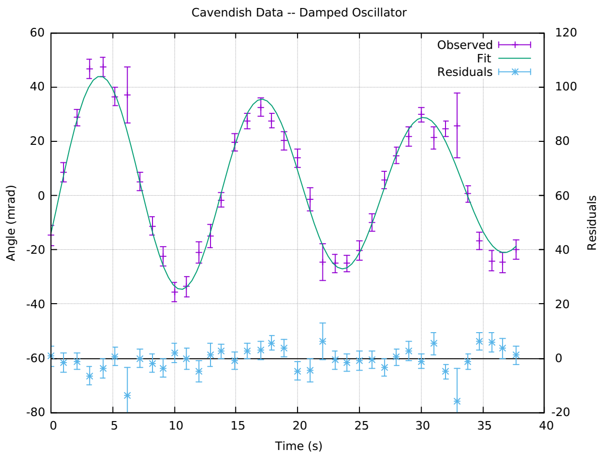
An image file will be rarely reproduced at its original size. As a thumb rule it will be scaled such that the width of the image in the journal will be equal to (or greater than, if necessary) the width of the text column. Authors must check that their figures are legible. Pay special attention to lettering and symbol sizes – they should be roughly equal to the main text size when the figure is scaled to column width as explained above.

JPG and PNG are bitmap file formats (i.e. they are composed of a fixed number of coloured dots) while PDF is a vector format (i.e. it is composed of analytical curves). Hence JPG and PNG usually reproduce poorly when scaled, while PDF is freely scalable without loss of quality. Moreover, JPG is an inherently lossy format; it preserves less detail of information than the original file – the original file may be a graph, a computer generated drawing or a digital image from a camera.

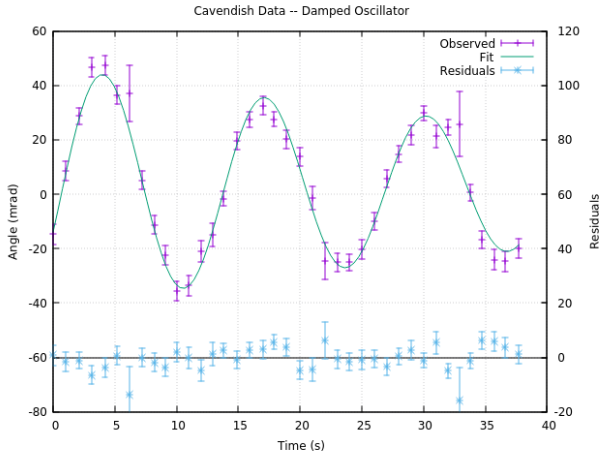
Images that are outputs of graphs or machine drawings (CAD) are best reproduced in the PDF format. However attention needs to be given to ensure sufficient thickness of lines and strokes and lettering size. If a bitmap is considered necessary, the image should be saved as PNG, not JPG. For exporting schematic diagrams or sketches drawn with graphics software as an image file PNG is better suited than JPG. JPG should be used only for photographs, as it is optimised for images of real scenes taken by a camera, but for little else, even though it is very often and improperly used as default format for all kinds of images.

Shown below are three images of the same graph rendered respectively as PDF, PNG and JPG. The difference in quality is easily seen when the image is scaled up or down from its native size. By and large, PDF reproduces the best, JPG the worst, as can be seen here (on-screen zooming will make the difference obvious). The PNG and JPG images are both 480$\times$ 640 pixels and the file sizes are 44 and 34 kB respectively, while the PDF file is only 16 kB. For PDF images, make sure that the bounding box is tight, that is there is no whitespace around the graphic. This can be done using the program 'pdfcrop'.

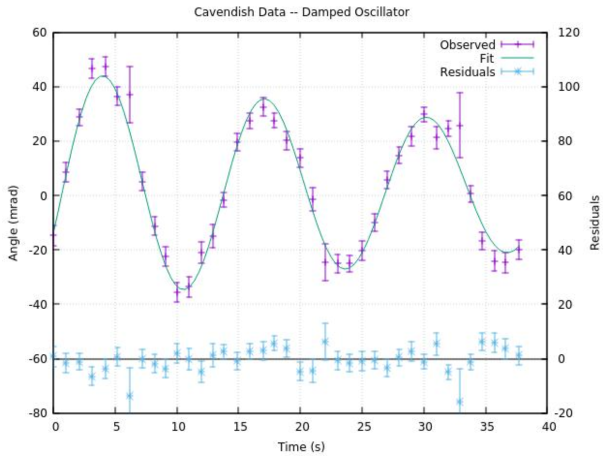
PDF



PNG



JPG



When including a graphic in a LaTeX file, its size should be specified relative to the size of the text column rather than by specifying its height and width separately (doing the latter might change the aspect ratio). This is done with the command

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\includegraphics
[width=x\columnwidth]{filename}
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where x is a number $\leq$ 1. The graphicx package will scale the height (or width) correctly if the width (or height) is specified.

Lettering and symbols in a figure should be large enough. A rule of thumb is that when the figure occupies the column-width, the letters in the graphic should appear as large as the main text. Clearly the lettering in the figures to the left is too small!

Acknowledgments

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References

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