Example 1: Audience

This example looks at how writing is tailored to different audiences, using the recent discovery of gravity waves as an example. This was reported in all levels of media, and below are five examples of how one element of the experiment, the interferometer, was described for different audiences.

Read the examples, and associated the example with the right reference and audience. Think about what signifies a text is written for a particular audience. Don't Google!
The references are:
1) Specialist physics audience (Abbott et al., Phys. Rev. D 95, 062003 (2017)
2) Semi-specialist physics audience (from the paper, Abbott et al, PRL 116, 061102 (2016)))
3) General physics audience (Physics Today 69, 4, 14 (2016))
4) General science audience (from Science)
5) general public (from The Verge))

Example A
"LIGO watches for a minuscule stretching of space with what amounts to ultraprecise rulers: two L-shaped contraptions called interferometers with arms 4 kilometers long. Mirrors at the ends of each arm form a long "resonant cavity," in which laser light of a precise wavelength bounces back and forth, resonating just as sound of a specific pitch rings in an organ pipe. Where the arms meet, the two beams can overlap. If they have traveled different distances along the arms, their waves will wind up out of step and interfere with each other. That will cause some of the light to warble out through an exit called a dark port in synchrony with undulations of the wave."

Example B
These detectors, H1 located on the Hanford Reservation in Richland, Washington, and L1 located in Livingston Parish, Louisiana, are laser interferometers [2] that use four mirrors (referred to as test masses) suspended from multi-stage pendulums to form two perpendicular optical cavities (arms) in a modified Michelson configuration, as shown in Fig. 1. GW strain causes apparent differential variations of the arm lengths which generate power fluctuations in the interferometer's GW readout port. These power fluctuations, measured by photodiodes, serve as both the GW readout signal and an error signal for controlling the differential arm length [3]. Feedback control of the differential arm length degree of freedom (along with the interferometer's other length and angular degrees of freedom) is required for stable operation of the instrument. This control is achieved by taking a digitized version of the GW readout signal derr(f), applying a set of digital filters to produce a control signal dctrl(f), then sending the control signal to the test mass actuator systems which displace the mirrors.

Example C
"The LIGO collaboration has two observatories in Louisiana and Washington State, both funded by the National Science Foundation. Each facility is shaped like a giant "L;" the "arms" of the L are two vacuum-sealed tubes stretching 2.5 miles long, with mirrors at each end. The mirrors are used to measure how gravitational waves warp space-time. When a gravitational wave passes, one mirror gets closer while the other retreats; scientists measure this phenomenon by bouncing lasers off the mirrors. Changes in the amount of time it takes a laser to bounce off a mirror indicate a gravitational wave."

Example D
"To achieve sufficient sensitivity to measure gravitational waves, the detectors include several enhancements to the basic Michelson interferometer. First, each arm contains a resonant optical cavity, formed by its two test mass mirrors, that multiplies the effect of a gravitational wave on the light phase by a factor of 300 [48]. Second, a partially transmissive power-recycling mirror at the input provides additional resonant buildup of the laser light in the interferometer as a whole [49,50]: 20 W of laser input is increased to 700 W incident on the beam splitter, which is further increased to 100 kW circulating in each arm cavity. Third, a partially transmissive signal-recycling mirror at the output optimizes the gravitational-wave signal extraction by broadening the bandwidth of the arm cavities

[51,52]. The interferometer is illuminated with a 1064-nm wavelength Nd:YAG laser, stabilized in amplitude, frequency, and beam geometry [53,54]. The gravitational-wave signal is extracted at the output port using a homodyne readout [55]."

Example E

"The observed strain, a mere 10^{-21}, implies that the length changes in LIGO's arms were 1/1000 the radius of an atomic nucleus. At face value, that's an impossibly small value to measure. LIGO's solution is to turn each arm into a resonant optical cavity (see figure 2). Light injected into the cavities bounces back and forth hundreds of times before recombining. In effect, the cavity increases the light's path length from 4 km to more than 1000 km. The attometer-size length change in the arms thus becomes a more manageable, although still impressive, femtometer-size difference in the light's path length."

Example 2: Story

Deterministic Nonperiodic Flow[1]

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(Manuscript received 18 November 1962, in revised form 7 January 1963)

ABSTRACT

Finite systems of deterministic ordinary nonlinear differential equations may be designed to represent forced dissipative hydrodynamic flow. Solutions of these equations can be identified with trajectories in phase space. For those systems with bounded solutions, it is found that nonperiodic solutions are ordinarily unstable with respect to small modifications, so that slightly differing initial states can evolve into considerably different states. Systems with bounded solutions are shown to possess bounded numerical solutions.

A simple system representing cellular convection is solved numerically. All of the solutions are found to be unstable, and almost all of them are nonperiodic.

The feasibility of very-long-range weather prediction is examined in the light of these results.

1. Introduction

Certain hydrodynamical systems exhibit steady-state flow patterns, while others oscillate in a regular periodic fashion. Still others vary in an irregular, seemingly haphazard manner, and, even when observed for long periods of time, do not appear to repeat their previous history.

These modes of behavior may all be observed in the familiar rotating-basin experiments, described by Fultz, *et al.* (1959) and Hide (1958). In these experiments, a cylindrical vessel containing water is rotated about its axis, and is heated near its rim and cooled near its center in a steady symmetrical fashion. Under certain conditions the resulting flow is as symmetric and steady as the heating which gives rise to it. Under different conditions a system of regularly spaced waves develops, and progresses at a uniform speed without changing its shape. Under still different conditions an irregular flow pattern forms, and moves and changes its shape in an irregular nonperiodic manner.

Lack of periodicity is very common in natural systems, and is one of the distinguishing features of turbulent flow. Because instantaneous turbulent flow patterns are so irregular, attention is often confined to the statistics of turbulence, which, in contrast to the details of turbulence, often behave in a regular well-organized manner. The short-range weather forecaster, however, is forced willy-nilly to predict the details of the large-scale turbulent eddies—the cyclones and anticyclones—which continually arrange themselves into new patterns. Thus there are occasions when more than the statistics of irregular flow are of very real concern.

In this study we shall work with systems of deterministic equations which are idealizations of hydrodynamical systems. We shall be interested principally in nonperiodic solutions, i.e., solutions which never repeat their past history exactly, and where all approximate repetitions are of finite duration. Thus we shall be involved with the ultimate behavior of the solutions, as opposed to the transient behavior associated with arbitrary initial conditions.

A closed hydrodynamical system of finite mass may ostensibly be treated mathematically as a finite collection of molecules—usually a very large finite collection —in which case the governing laws are expressible as a finite set of ordinary differential equations. These equations are generally highly intractable, and the set of molecules is usually approximated by a continuous distribution of mass. The governing laws are then expressed as a set of partial differential equations, containing such quantities as velocity, density, and pressure as dependent variables.

It is sometimes possible to obtain particular solutions of these equations analytically, especially when the solutions are periodic or invariant with time, and, indeed, much work has been devoted to obtaining such solutions by one scheme or another. Ordinarily, however, nonperiodic solutions cannot readily be determined except by numerical procedures. Such procedures involve replacing the continuous variables by a new finite set of functions of time, which may perhaps be the values of the continuous variables at a chosen grid of points, or the coefficients in the expansions of these variables in series of orthogonal functions. The governing laws then become a finite set of ordinary differential

[1] The research reported in this work has been sponsored by the Geophysics Research Directorate of the Air Force Cambridge Research Center, under Contract No. AF 19(604)-4969.

equations again, although a far simpler set than the one which governs individual molecular motions.

In any real hydrodynamical system, viscous dissipation is always occurring, unless the system is moving as a solid, and thermal dissipation is always occurring, unless the system is at constant temperature. For certain purposes many systems may be treated as conservative systems, in which the total energy, or some other quantity, does not vary with time. In seeking the ultimate behavior of a system, the use of conservative equations is unsatisfactory, since the ultimate value of any conservative quantity would then have to equal the arbitrarily chosen initial value. This difficulty may be obviated by including the dissipative processes, thereby making the equations nonconservative, and also including external mechanical or thermal forcing, thus preventing the system from ultimately reaching a state of rest. If the system is to be deterministic, the forcing functions, if not constant with time, must themselves vary according to some deterministic rule.

In this work, then, we shall deal specifically with finite systems of deterministic ordinary differential equations, designed to represent forced dissipative hydrodynamical systems. We shall study the properties of nonperiodic solutions of these equations.

Example 3: Paragraph structure

The paragraph below is an example of how *not* to structure your writing. It is the first paragraph of the introduction to a paper, and describes the reason for the experiment done. Try to identify the main idea of the paragraph, and think about why the paragraph is hard to read. Then, read the rewritten version.

Original text (230 words)

Calcium fluoride is a cubic material. Rare-earth ions were known to occupy different sites due to charge compensation. Hamers *et al.*[1] identified five different sites in CaF_2 :Eu^{3+} 0.1% whose $^7F_0 \rightarrow {}^5D_0$ absorption wavelengths fall at 579 0.6 nm. High-resolution spectral studies were also performed on these materials by the hole-burning technique. Hole-burning studies of the tetragonal site[2] and oxygen-compensated trigonal site were performed in the past.[3 – 5] Hole burning was also pursued in several other europium-doped crystals and glasses.[6 – 10] The $^5D_0$ and $^7F_0$ states of Eu^{3+} are singlets in the crystal field. A transition between these two states is expected to reveal a single peak either in absorption or emission, in defect free perfect crystals. A recent investigation[11] on the $^7F_0 \rightarrow {}^5D_0$ transition of Eu^{3+} doped Y_2SiO_5 revealed more than 40 different satellite lines for the dopant though the prior studies revealed only two sites.[12] Similar observations were made in $EuVO_4$[13] and $YAlO_3$:Eu^3 [14] also. The satellite lines were ascribed to ions that were on the sites differently perturbed, by defects or clustering of Eu^{3+} ions. It is not clear yet whether this multisite behavior is universal or dependent on the host material. So, we reinvestigated the high-resolution spectroscopy and hole-burning phenomena in CaF_2 :Eu^3 . Our studies revealed more than 40 different sites for the Eu^{3+} ion whose transition wavelengths ($^7F_0 \rightarrow {}^5D_0$) fall within 1 nm centered around 579.5 nm.

Edited text (167 words)

Rare earth dopant ions normally exist in crystals as substitutional defects. The number of substitutional sites the dopant occupies in the crystal can be determined from the number of lines in the optical spectrum of the dopant ion. For this purpose, the $^7F_0$-$^5D_0$ transition of Eu^{3+} is particularly useful, since both levels are singlets and so each site gives rise to only a single peak in the emission or absorption spectrum.

Recent measurements in Eu:Y_2SiO_5[1], $EuVO_4$ [2], and Eu:$YAlO_3$[3], found many more sites than previously seen. In Eu:Y_2SiO_5, for example, two sites were expected but over forty sites were observed. The extra lines were ascribed to ions in either perturbed sites, or in Eu^{3+} clusters.

In this study, we revisit Eu^{3+} :CaF_2, in which five sites have previously been seen [4], to determine whether the same perturbed and cluster sites are present. Using high resolution and holeburning spectroscopy, we find over forty different Eu sites with wavelengths for the $^7F_0$-$^5D_0$ transition within 1 nm of 579.5 nm.