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Arrow of Time in the Succesive Stages of Development of Flowers

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Abstract: In this work we present a simple example of the growth of a flower in the successive stages of development and show how the direction of time (Arrow of time may be represented in these cases).
Keywords: Arrow of time.

I. INTRODUCTION

One way of looking at a problem is from analogy. In many ways some phenomena in physics appearing in different domains are quite analogous. There are numerous examples to support this. Recently we have worked out few analogies which cover specific topics like spatial hole burning, multiple reflection and squeezed states [1], electromagnetically induced transparency and dispersion curves in semi classical theory of laser [2] and spatial hole burning and some non physics contexts [3]. In a recent paper [4] we have also shown how such an analogy which concerns the characteristics properties of laser radiation and a model of the universe involving space time and quantum cosmology exists. In this paper we are primarily concerned with a familiar topic of the growth of a flower in the successive stages of development commencing from the tender bud which has a greenish hue and proceeding by steps to the mature flower exhibiting a full colour and how the so-called arrow of time [5] may be represented in this case (as analogy)

II. DIRECTION OR ARROW OF TIME

We now introduce the topic of the direction or arrow of time in cosmology as discussed by Hawking [5] few decades ago. In this work Hawking indicates that the universe that we live in certainly does not appear time symmetric, as anyone who has watched a movie being shown backward can testify: one sees events that are never witnessed in ordinary life. One can distinguish a number of different "arrows" of time that express the time asymmetry of the universe. (1) The thermodynamic arrow of time in which entropy increases (2) The psychological arrow of the is the way time appears to flow in our mind – the way we experience the increasing aging of our bodies, remember events in the past but have no direct information of the future. (3) The cosmological arrow of time: the direction in time in which the universe is expanding from the big bang. There is also an arrow of time which Hawking called an electrodynamics arrow of time: the fact that one uses retarded solutions of the field equation rather than the advanced one. According to Hawking the first arrow implies the second and the second and third. In the case of psychological arrow this is true because we are or computers are governed by the thermodynamic arrow like everything else in this universe. The accepted explanation for the thermodynamical arrow of time is that for some reason the universe started out in a high order or low entropy. Such states occupy a very small fraction of the volume of the phase space accessible to the universe. As the universe evolves in the it will tend to move around phase space in ergodic manner. In this connection it is worthwhile to refer to the ergodic hypothesis in statistical mechanics concerning "phase space". If a system of n atoms is enclosed in fixed volume, the state of the system is given by a point in a 6N- dimensional phase space with q representing coordinates and p representing moment a. Taking the energy E to be constant a representative point in phase space describes an orbit on the surface$E(q\ p) = C$ where C is a constant. The ergodic hypothesis states that the orbit of the representative point in phase space eventually goes through all points on the surface.

As the universe evolves, a later time there is a high probability that it will be found in a state of disorder or higher entropy because such states occupy most of phase space. Consider again, the example given by Hawking [5], a system consisting of N of gas molecules in a rectangular fox which is divided into two by a partition with a small hole in it. Suppose at a particular time all the molecules are in the left- hand side of the box. Such configurations occupy only one part of the box. Such configurations occupy only one part in 2^N of the available phase space (6N- dimensional). As time evolves the system will move around phase space on a constant energy surface. At a later time there will be higher probability of finding the system in a more disorder state with molecules in both halves of the box. Thus entropy will increase with time. But if one waits long enough, one will eventually see all molecules returning to one half of the box. However for macroscopic values of N, the time taken by the system is infinitely large and it is likely to be much longer than the age of the universe. This is presumably the ergodic hypothesis. It is now worthwhile to close this section with the remark that the relevant mathematics which concern the arrows of time are more involved. We shall concern ourselves in the following section with a more elementary approach to represent arrows of time which we believe is relevant for science education.

II. SUCCESSIVE STAGES OF DEVELOPMENT OF FLOWERS:

It is quite instructive to examine the flower of a plant in the successive stages of development commencing from the tender bud which has a greenish tint and proceeding by steps to the mature flower exhibiting a full colour. For the purpose of illustration we have reproduced the photographs of few specimens of flowers at different stages and times. It is worthwhile to note here that we could have selected numerous other examples for the purpose of our illustration. The considerations set forth in the present case are also applicable in these cases.

Fig 1. Photographs of Hibicus (Hibiscus rosa-sinensis) flowers at successive stages of development

Fig 2. Photographs of Thalia (Thalia Dealbata) flowers at successive stages of development

Fig 3. Photographs of Anthurium (Anthurium andraeanum) flowers at successive stages of development

Fig 4. Photographs of Chrysanthemum (Dendranthema grandiflora) flowers at successive stages of development

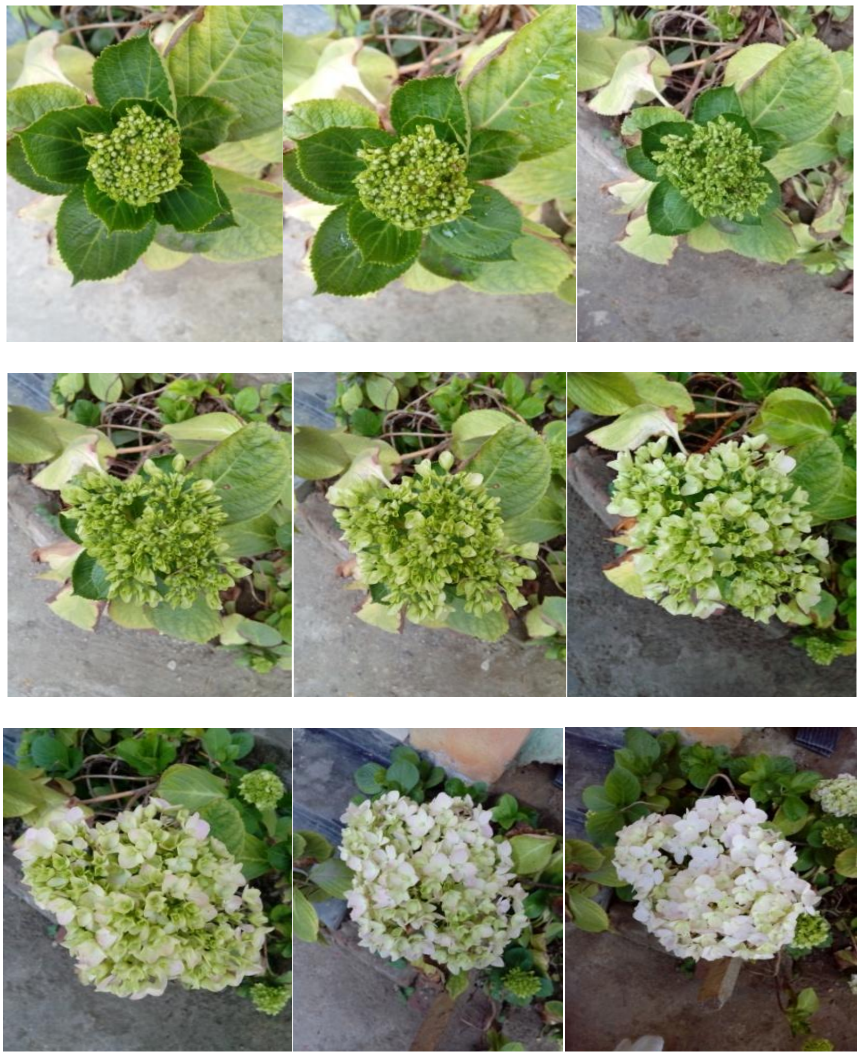

Fig 5. Photographs of Hydrangea (Hydrangea macrophylla) flowers at successive stages of development

Fig 6. Photographs of Azalea (Rhododendron Pentanthera) flowers at successive stages of development

Fig 7. Photographs of Impatiens (Impatiens walleriana) flowers at successive stages of development

In all the figures the time has been taken as orbitary and photographs have been after every twenty four hours. It is now appropriate and worthwhile to include all the considerations set forth in the earlier sections, including this, in a tabular form so that some of the characteristic features of the arrow of time may be usualised.

Table 1.Summary of the characteristics in the successive stages of the development of flower (events).

Quantity	Event	Remark
Entropy	Entropy increase as the flower grows in size at different time	Arrow of time is directed along the direction of the increase in disorder.
Symmetry	Successive stages of growth is asymmetric in time	This is the feature of the nature we live in
Build up process	The flower initially builds up from a tender bud which indicates some sort of fluctuation	In a very recent theory of 1914 it has been shown by rigorous method that the universe can be created spontaneously from large scale vacuum fluctuations. [6]
Growth process	Irreversible, the species grows exponentially in the initial stage	The theory [6] indicates that the true vacuum bubble expands rapidly and the universe can be created irreversibly.

III. SUMMARY AND CONCLUSION

In summary, we have present a simple example of the growth of a flower in its successive stages of development and show how the arrow of time may be represented in these cases. We believe that the work is relevant for science education.

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