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Application of Parallel Processing - A Case Study on Computational Astrophysics

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***Abstract*—In astronomy, billions of objects both galactic and extra galactic, allow new studies and discoveries. These huge amount of astronomical data requires great databases that will provide sufficient space and accessibility. This paper presents the utilization of parallel supercomputer that will allow the new studies of computational astrophysics be performed. The major parallel supercomputers are lastly approaching the rapidity and memory compulsory to solve the related astrophysics problems. From astronomy perspective, when the stars are dying, they will become black holes, and are usually developed when very huge star dies in a supernova. In this study, the formation of the black holes is discovered by using numerical algorithm that is suitable for astrophysics. However, the objects of intrigue stars and universes are not available to any sort of control. No trials can be performed, and perceptions of a specific one-time occasion cannot be rehashed. The circumstance is additionally confused because the physical procedures offering ascend to the astrophysical wonder. Therefore, the use of parallel and superior computers would offer the right choice of solution in dealing with this particular segment of computational astrophysics.**

***Keywords:* parallel supercomputer, astrophysics, black holes**

I. Introduction

Numerous astrophysicists utilize personal computers (PCs) in their work. The increasing number of astrophysics in these sections today have study groups who are especially keen to computational astrophysics. Novel law in astronomy links with up-to-date computational approaches, new hardware plan and advanced calculations for together recreations and information of the analysis. Additionally, unique software operations and related advancement are quickly raising to determine recent marvels and to estimate in astronomy, cosmology and planetary sciences.

Most dynamical astrophysical issues must be analysed theoretically in detail with utilizing extensive computer models [1]. They utilize some of the major supercomputers in the world to show a wide choice of galactic, going from nonexclusive little scale vitality discharge handle in polarized plasma, through relativistic impact less stuns to the development of stars and planets. Recently, the trends show the wide utilization of parallel and superior computers in this computational astronomy [2].

The combination of these controls prompts an extensive variety of points in terms of astronomical perspective. These shelter all ranges of disciplines as well as ironic palette of statistics, physics and chemistry. It is understood in the widest logic that the it may well contain segments of hardware, method, operating system, networking, contraction and administration of huge information. The information derives from the use of expansive telescopes and reviews, modelling, recreation, imagining, speedy calculating, data concentrated figuring and engine education.

To perform the calculation of astrophysics by using numerical methods, there are many vital systems of computational astrophysics. These include Particle-in-cell (PIC), Particle-Mesh (PM), N-body simulations, Monte Carlo methods and also the most importantly the grid-free smoothed particle hydrodynamics (SPH). Moreover, ODE and PDE that are used to solve numerical analysis are also employed to calculate in computational astrophysics. There are many uses of computer in astrophysics, for example in controlling the instruments, satellite, telescopes, MUSE, VLA, and HST. These are also used in discovered data analysis, data reduction, IDL, 3dCube, FITS, Fourier analysis, N-body simulation (Fig. 1), hydrodynamics (Fig. 2) and Monte-Carlo for numerical and modelling.

By then, there are many codes and software that offer along with the uses of computational astrophysics. For instance, n-body code includes ChaNga, nbodylab.org and Starlab. Most of these codes tend to be fluid solvers of some categories or n-body packages.

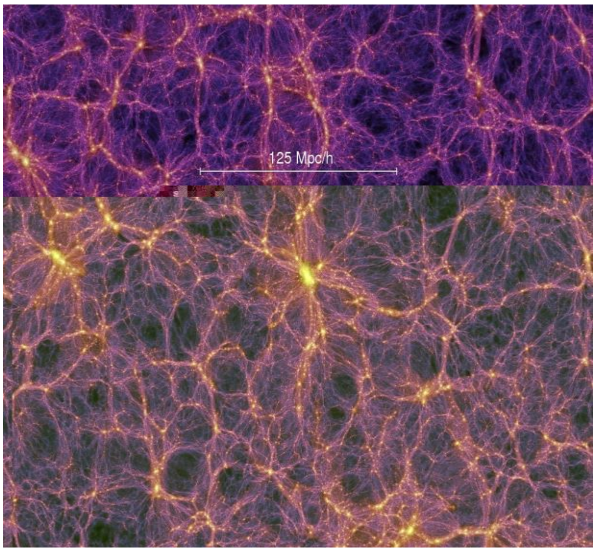

Fig. 1. Example of N-body simulation [1]

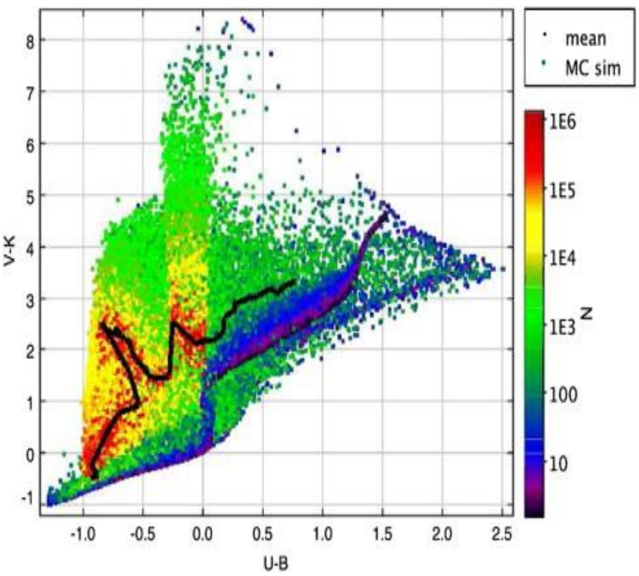

Fig. 2. Example of hydrodynamics [1]

II. BACKGROUND

There are many objects in our galaxy. Sun, stars, extrasolar planets, black holes, the interstellar medium and the cosmic microwave background are most of the objects that were studied. The astrophysicists are trying to achieve their objectives in finding about galaxies such as to identify the characteristics of dark matter, to identify dark energy, and black holes which are part of study for them. The most recognized object in astronomy is stars in which they represent the essential building blocks of galaxies.

A star is a shining sphere of plasma that is grasped and organized through its gravity. Sun is the nearest star to our Earth. During the night, we could not see stars clearly with our naked eyes. They simply appear as shining points in the sky distance due to their massive gap from Earth. Stars arrangement from inside are quite solid absorptions of dust and molecular clouds which are space gas. These extent in temperature from about 10 to 20K which are extremely cold [3]. Gases will become molecular meaning that the atoms bind together at this temperature [4] (Fig. 3).

Other than that, another object is black holes. A black hole is an area in interstellar where gravity exerts a pull on so much that even light cannot escape. Because of matter has been hugged into a small space, the gravity become robust [5]. This can occur when a star is becoming destroyed. Because of the light that can be ambiguous and is unseen, so black holes cannot be seen by individuals. Space telescopes with special equipment is the only one that can support to do discovery on these black holes. How the stars are quite near to the black holes can only be seen by using the special tools of telescopes. The black holes are acted in a different way than the other stars.

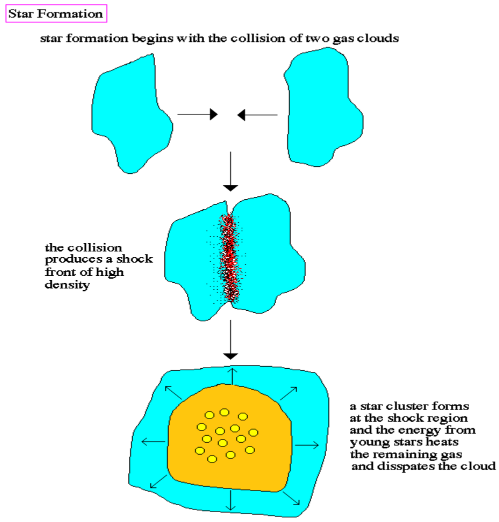

Fig. 3. It shows a star formation [4]

A. Definition

According to Oxford dictionary, computational means something that is related to computer or process of mathematic calculation. Next, astrophysics means the division of astronomy that uses the law of physics and chemistry to establish the nature of the wonderful figures, rather than their positions or motions in space [6]. Lastly, computational astrophysics refers to the procedures and figuring instruments to express and are used in astrophysics investigation [7].

III. PROBLEM STATEMENT

It is discovered that when stars are dying, they will become black holes. Black holes are usually developed when very huge star dies in a supernova. Stars with very excessive masses is the only one that can evolve into black holes. For instance, our Sun is not huge to form a black hole. Once the Sun turns out of the accessible nuclear gas in its fundamental, the Sun resolves demise a muted decease about four billion years from now. Stars like this kind end their antiquity as white dwarf stars [8]. However, it is not known how big does a star should be to become a black hole one day.

IV. RESULT

Black holes can be large or slight. Researchers believe that the slightest black holes are very small just like one atom. These black holes have larger mass but it is very minuscule. In an object, mass is the amount of matter. Stellar is one of black hole. Its mass can be up to 20 times over the mass of the sun. In Earth's galaxy, it may be having many stellar mass black holes which is called Milky Way. Supermassive is the biggest black holes. This black holes have masses which are over one million suns [9]. It has been proven by the researchers that at the midpoint of every large galaxy, it has supermassive black holes. The Sagittarius is one of the supermassive black hole at the midpoint of the Milky Way galaxy which has a mass equivalent to about 4 million suns. The main sphere could also grasp a few million Earths [10].

TABLE 1
TYPE OF BLACK HOLES

Class	Mass	Size
Supermassive black hole	~10^5–10^{10} M_{Sun}	~0.001–400 AU
Intermediate-mass black hole	~10^3 M_{Sun}	~10^3 km ≈ R_{Earth}
Stellar black hole	~10 M_{Sun}	~30 km
Micro black hole	up to ~M_{Moon}	up to ~0.1 mm

Only stars by actual higher masses can be black holes [11] (Table 1). For instance, the Sun is not huge sufficient toward to be a black hole. When our Sun turns available to the accessible nuclear gas in its essential, it will break down a low end in four billion years from now [12]. So, it will turn end its history as white dwarf stars. It might finally make a black hole once there are additional gigantic stars, for example those with masses of over 20 times our Sun's mass. After a gigantic star turns available of nuclear gas, it no longer bears its individual weight and starts to breakdown. When it happens, it will be supernova in which the high temperature of star rises up and some segment of its external sheet, which frequently still has some new nuclear fuel, starts the nuclear feedback once more and blow up. Then, the remaining inmost segment of the star, the core, will last to breakdown. It might turn out either a neutron star and start the breakdown or it might endure to breakdown into a black hole depends on how massive the core. About 2.5 solar masses of the in-between the mass of the core in which it is determined by its luck. It is believed that it must to start with over 20 solar masses to provide a core of 2.5 solar multitudes of the inherited star. Stellar black holes is a black hole formed from a star [13] (Fig. 4).

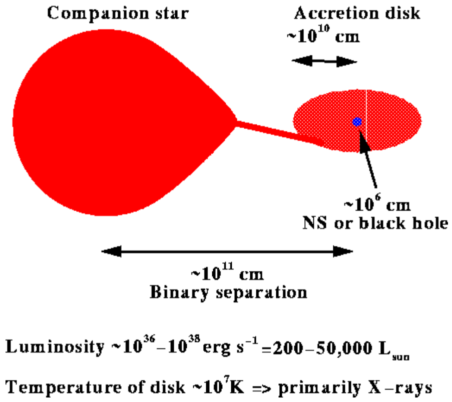

Fig. 4. Formation of star to black holes [13]

The star that is called Chandrasekhar limit which is better 1.4 times than an inclination mass of sun will explode in the supernova forming off plentiful of their mass [14]. A slight essential core will continue and alike lesser stars. It will breakdown once the period electron corruption will not be enough to sustenance the star's mass in contradiction of its gravitational breakdown. It will last to become smaller then. It will be a tiny, but massively huge, neutron star detained simultaneously by neutron corruption.

It will last to become smaller until the substance is all compressed into substantially small, if neutron exploitation is not enough to fight the star's breakdown. Singularity is an extremely solid point which is the centre of a black hole (Fig. 5).

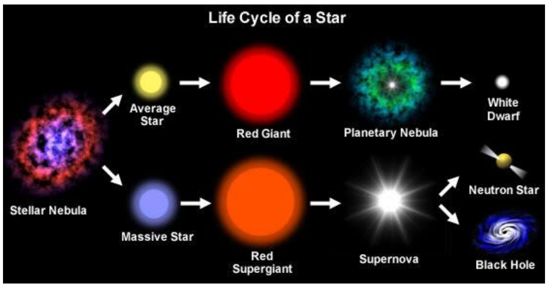

Fig. 5. It shows a life cycle of a star into black hole [14]

V. CONCLUSION

Various astrophysicists generally utilize their personal computers in their work. These astrophysics today have study groups which are especially keen to computational astrophysics. As black holes can be large or slight, stargazing researchers believe that the slightest black holes are very small just like one atom. These black holes have larger mass but it is very minuscule. In this paper, it shows that the bigger the star, the more chances it will produce black holes. It is shown that these black holes have a mutual bond with their host galaxies. It will later become smaller until the substance is all compressed into substantially small, if neutron exploitation is not enough to fight the star's breakdown. The use of parallel and superior computers would provide the appropriate choice of solution in dealing with this specific section of astronomical mystery.

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