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A fractal analysis of the dependence of the three-body problem on initial conditions

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The Newtonian three-body problem, which evaded complete solutions for centuries has in the recent decades been investigated in light of fractals. Fractal patterns have been shown to arise in many contexts of the problem. The present research analyses the behaviour of a planar three-body system in relation to its initial conditions. While the initial positions of two of the bodies are kept constant, that of the 3rd is varied on the coordinate plane. The initial position of the third body leads the system to three possible types of paths: collision, escape, and bounded. Out of these, the basins of attraction of the collision orbits are plotted. The *Verlet* method of symplectic integration is used on Newton's law of gravitational attraction to calculate the paths of the bodies using *Python* code. The fractals obtained have riddled basins of attraction with ring patterns. Fractals where the initial velocity and the mass of the third body are varied are analysed. It is observed that with the increment of mass of the 3rd body, ring patterns in the basins become enlarged, while the symmetry of the fractal is preserved. With the increment of the initial velocity of the 3rd body, asymmetry in the fractal pattern increases. The systems such as those investigated in the research where the 3rd body is more massive than the other two find their astrophysical significance in systems such as the Pluto-Nix-Hydra system and the D9 binary star system orbiting the supermassive black hole Sagittarius A* at the centre of the Milky Way.

Keywords: *Basins of attraction, riddled basins, ring patterns, symmetry, Verlet integration*