



# PHYSICS IN NEW DIMENSIONS

Dr. Prianka Sharma

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# Chapter 5

## PHYSICS AND PHENOMENOLOGY OF DARK MATTER

Gazal Sharma<sup>1</sup>, B. C. Chauhan<sup>1</sup> and Debasish Majumdar<sup>2</sup>

<sup>1</sup>Department of Physics & Astronomical Science, Central University of Himachal Pradesh (CUHP), Dharamshala, Kangra, H.P

<sup>2</sup>Astroparticle Physics and Cosmology Division, Saha Institute of Nuclear Physics, Kolkata, W.B.

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*A cosmic mystery of immense proportions, once seemingly on the verge of solution, has deepened and left astronomers and astrophysicists more baffled than ever. The crux ... is that the vast majority of the mass of the universe seems to be missing.*

— William J. Broad

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### Introduction

The Universe came into being from a singularity in one explosive event about 13.7 billion years ago. This explosive beginning is called “THE BIG BANG”. In 1929, the astronomer Edwin Hubble had discovered this expansion of the Universe. He observed that all galaxies have a positive redshift. In simple terms this observation implies that, all the galaxies were receding from the Milky Way. Redshift occurs when a light source moves away from its observers. Due to this the apparent wavelength of light is stretched by the Doppler Effect towards the red side of the spectrum. Hubble’s observation indicated that the distant galaxies were moving away from us, as the farthest galaxies had the fastest apparent velocities. If galaxies are moving away from us, then at some point of time in the past, they must have been arranged or we can call as “clustered” together. A light source suffers a new shift with respect to an observer when the source moves away from the observer.

Hubble’s discovery was the first observational support for Georges LeMaitre’s Big Bang theory of the Universe, proposed in 1927. According to that, the expansion of the observable Universe began with the explosion of a single particle at a definite point in time. He proposed that the Universe expanded explosively from an extremely dense and hot state, and continuously expanding till today. Subsequent calculations have dated this Big Bang to approximately 13.7 billion years ago. In 1998 two teams of astronomers working independently at Berkeley, California discovered by measuring the distances of different Supernova. In that they are receding from each other at an accelerating rate. This earned