Hubble Space Telescope

Cycle 16 AR Proposal

Intermediate Mass Black Holes in Globular Clusters: Key Photometric Fingerprints

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Theory: Yes

Abstract

Intermediate Mass Black Holes (IMBHs) are important and interesting objects. Their existence has been predicted in different astrophysical contexts, such as in runaway collapse of massive stars in Globular Clusters (GCs) and as remnants of the explosion of Pop III stars in the early universe. Ultra Luminous X-ray sources observed in various environments may be IMBHs, but their nature remains poorly understood. GCs may ultimately present the best chance of finding IMBHs. HST line-of-sight velocity studies have suggested IMBHs in M15 and G1, but these detections are not unambiguous. HST proper motion studies are now also underway, but these are challenging and have not yet yielded any detections. This proposal therefore addresses an alternative approach for finding IMBHs in GCs with HST, namely through their photometric signature. Numerical simulations have shown only recently that IMBHs leave a clear photometric signature in GCs that differs considerably from the simplified analytical predictions that have been accepted for decades. Instead of a steep cusp, an IMBH induces a shallow cusp within a large core radius. Recent WFPC2-HST archival analysis by Noyola & Gebhardt has shown that many GCs have surface brightness profiles that are generically consistent with this prediction. However the data-model comparisons carried out to date have not been sophisticated: only projected mass profiles were derived from N-body models and there has been no attempt to simulate real data, taking into account star colors, luminosities, PSFs, and crowding. Therefore we propose to facilitate credible IMBH detections in GCs based on photometry by: (a) running sophisticated N-body simulations of star clusters with IMBHs, primordial binaries and stellar evolution; and (b) simulating photometric datasets from these observations and deriving surface brightness profiles from them using techniques similar to those customarily applied to real data. This work is ideally suited for the HST Theory program as HST is the only telescope with sufficient resolution to measure photometric profiles down to the required resolution. Much effort has been invested in such GC observations (e.g., a 134-orbit Cycle 14 ACS survey - PI Sarajedini), yet theoretical simulations are generally not performed as part of such programs. Our work will be important for the interpretation of these and other data, and it will complement efforts to detect IMBHs in globulars using dynamics or X-ray observations.

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Dataset Summary:

Instrument	No. of Datasets	Retrieval Method	Retrieval Plan