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## 1 Introduction

Oppenheimer & Snyder (1939) made the first rigorous calculation describing the formation of a black hole (BH). The first strong evidence for such an object came from X-ray and optical observations of the X-ray binary Cygnus X-1 (Bolton 1972; Webster & Murrin 1972). Today, a total of 20 similar X-ray binary systems are known that contain a compact object believed to be too massive to be a neutron star or a degenerate star of any kind (i.e.,  $M > 3 M_{\odot}$ ). These systems, which we refer to as black-hole binaries (BHBs), are the focus of this review.

These 20 dynamical BHs are the most visible representatives of an estimated  $10^8$ – $10^9$  stellar-mass BHs that are believed to exist in the Galaxy (e.g., Brown & Bethe 1994; Timmes, Woosley, & Weaver 1996). Stellar-mass BHs are important to astronomy in numerous ways. For example, they are one endpoint of stellar evolution for massive stars, and the collapse of their progenitor stars enriches the universe with heavy elements (Woosley et al. 2002). Also, the measured mass distribution for even the small sample featured here is used to constrain models of BH formation and binary evolution (e.g., Fryer & Kalogera 2001; Podsiadlowski et al. 2003). Lastly, some BHBs appear to be linked to the **hypernovae** believed to power **gamma-ray bursts** (Israelian et al. 1999; Brown et al. 2000; Orosz et al. 2001).

The BHBs featured here are mass-exchange binaries that contain an accreting BH primary and a nondegenerate secondary star. For background on X-ray binaries, see Psaltis (2006). For comprehensive reviews on BHBs, see McClintock & Remillard (2006), Tanaka and Shibazaki (1996) and Tanaka & Lewin (1995). X-ray observations of BHBs allow us to gain a better understanding of BH properties and accretion physics. In this review, we emphasize those results that challenge us to apply the predictions of general relativity (GR) in strong gravity (§8). Throughout, we make extensive use of the extraordinary data base amassed since January 1996 by NASA's *Rossi X-ray Timing Explorer* (RXTE; Swank 1998).

In an astrophysical environment, a BH is completely specified in GR by two