

The hallmark of the steep power law (SPL) state (formerly the very high state) is a strong PL component with  $\Gamma \sim 2.5$ . In some sources, this PL has been detected without a break to energies of  $\sim 1$  MeV or higher (§4.1). This state is also characterized by the presence of a sizable thermal component and the frequent presence of X-ray QPOs (see Table 2). An example of the SPL state is shown in the top row of panels in Figure 2, and many additional illustrations are displayed in McClintock & Remillard (2006). There are similarities between the SPL state and the thermal state; both show a thermal component and a steep PL component. However in the thermal state the PL is faint and has a more variable photon index, while the SPL state is plainly distinguished by its powerful PL component and the commonly-occurring QPOs. The SPL state tends to dominate BHB spectra as the luminosity approaches the Eddington limit, and it is this state that is associated with high-frequency QPOs (§6.2; McClintock & Remillard 2006).

**Intermediate states** and state transitions are another important aspect of BHB studies. The three states defined by McClintock & Remillard (2006) attempt to specify spectral and timing conditions that are quasi-stable and that appear to have distinct physical origins. There are gaps in the parameter ranges used to define these states (Table 2), and this gives rise to intermediate states. The hybrid of the hard and SPL states is particularly interesting for its correlations with radio properties (§4.3 and §5) and also with disk properties (§6.1).

#### 4.3 The Unified Model for Radio Jets

Many researchers investigate the spectral evolution of BHBs using a **hardness-intensity diagram (HID)**, which is a plot of X-ray intensity versus a “hardness ratio” ( $HR$ ), i.e., the ratio of detector counts in two energy bands (e.g., van der Klis 2005; Homan et al. 2001; Belloni 2004). This diagram is widely used in tracking the behavior of accreting neutron stars. Compared to the spectral-fitting approach described above, the HID approach has the advantage that it is model independent and the disadvantage that it is difficult to relate the results to physical quantities. Interpretations of variations in the HID depend on the particular energy bands chosen to define  $HR$  in a given study. If both bands are above  $\sim 5$  keV, then the  $HR$  value effectively tracks the slope of the PL component (i.e., lower  $HR$  is a steeper PL). Softer energy bands admit a mixture of thermal and nonthermal components, and interpretations are then more complicated.

The HID is also used in illustrating the “unified model for radio jets” proposed by Fender et al. (2004). Figure 3 shows their schematic for the relationships between jets and X-ray states, where the state of an observation is distinguished simply by the value of  $HR$ . The figure shows qualitatively how the jet Lorentz factor (*lower panel*) and the morphology of the jet (*sketches i – iv*) evolve with changes in the X-ray state. Tracks for state transitions of an X-ray source in the HID are also shown (*top panel*). The solid vertical line running through both panels in Figure 3 is the “jet line.” To the right of the jet line the X-ray spectrum is relatively hard and a steady radio jet is present, and to the left the spectrum is soft and the jet is quenched. The jet line also marks an instability strip where violent ejections of matter may occur (see *sketch iii*), as indicated by the spike in the Lorentz factor (*lower panel*). The tracks for state evolution in the HID are influenced by observations of GX 339–4 (Belloni et al. 2005). In the Belloni et al. study,  $HR$  was defined as the ratio of source counts at 6.3–10.5 keV to the