Thus, we conclude that either the V4641 Sgr is in-...F_\text{29.5 ks}, and the image size is 1.3 arcmin. The N and E errors are 1.3\%. The 2 detected sources are circled, and the 3 sources marked with 2 circles have MAKAS identifications. Source 1 is V4641 Sgr.

2 Targets, Detections, and Spectral Results

V4641 Sgr and XTE J1859+226 both had major X-ray outbursts in 1999 (Wood et al., 1999; Smith, Levine & Morgan, 1999). While the XTE J1859+226 outburst was typical of BH transients, the behavior of V4641 Sgr was unusual with the source undergoing an extremely bright (12 Crab) outburst lasting only 1-2 days. From optical observations covering the 67.6 hr V4641 Sgr orbit and the (likely) 8.6 hr XTE J1859+226 orbit, the compact object masses were above 6M_\odot, indicating that these systems contain BHs (Orosz et al., 2001; Filippenko & Chornock, 2001). At the time of the outburst, V4641 Sgr exhibited a one-sided, rapidly evolving, relativistic radio jet (Heilming et al., 2000; Orosz et al., 2001), and there is evidence that XTE J1859+226 also produced a radio jet (Brocksopp et al., 2000).

2.4 \pm 1.1 \times 10^{-22} \text{erg cm}^{-2} \text{s}^{-1}

Now, 14 out of the 15 transients with confirmed black holes have measured quiescent luminosities or sensitive upper limits. The luminosities for V4641 Sgr and XTE J1859+226 are consistent with the median luminosity of 2 \times 10^{37} \text{erg cm}^{-2} \text{s}^{-1} for the systems, with previous detections.

Our analysis suggests that the quiescent X-ray spectrum of V4641 Sgr is harder than for the other systems in this group.

3 Quiescent Black Hole Luminosities

The X-ray luminosity (L_x) for the measurements confirmed the transient BH systems are summarized in Figure 3. We include a new low X-ray flux measurement for XTE J1550–564 (Kaaret et al., 2003), which has not been previously considered in the context of studies of quiescent BHs, and we approximate a distance of 5.3 kpc (Orosz et al., 2002) to convert from flux to luminosity. We also include the lowest flux measurements for the recurrent transient GX 339–4 (Kong et al., 2002; Corbel et al., 2003), and we assume a distance of 4 kpc. The median luminosity is \(2 \times 10^{37} \text{erg cm}^{-2} \text{s}^{-1}\) for the 9 systems with previous detections, and the measured luminosities for V4641 Sgr and XTE J1859+226 are consistent with the median.

4 Discussion

Jet Emission? The V4641 Sgr source distance along with the proper motion of the one-sided radio jet seen in 1999 indicate that the angle between the jet axis and our line of sight is \(< 8^\circ\) (Orosz et al., 2001). Thus, if the X-ray emission originates in a fast-moving jet, one expects V4641 Sgr to be brighter due to relativistic beaming. However, the V4641 Sgr X-ray luminosity (assuming isotropic emission) is similar to the luminosities of the other BH systems, for which the jet axes are either not known or are known to be relatively far from our line of sight, indicating that the X-ray emission is not highly beamed and limiting the velocity of a putative X-ray emitting jet. For a continuous synchrotron X-ray jet (Markoff, Fawke & Fender, 2001), it is unlikely that the bulk-motion Lorentz factor could be higher than ~1.5 as this would cause the source to be brighter than an un-Beamed source by a factor of \(\approx 10\) for a jet that is \(\approx 5^\circ\) from our line of sight (Mirabel & Rodriguez, 1999). This calculation assumes a spectrum with a photon index of 1.5, which is in the range of values that can be produced with the Markoff, Fawke & Fender (2001) model. Assuming a photon index of 0.2 (our best estimate for V4641 Sgr) would lead to a somewhat higher limit on the Lorentz factor, but it is unclear whether such a hard spectrum could have a synchrotron origin. Also, we note that the Lorentz factor constraint is similar for models where X-rays are produced in jets via inverse Comptonization (Gehrels et al., 2002). The V4641 Sgr con-straint on the Lorentz factor (\(\Gamma < 5\)) is consistent with recent results for BH systems in the canonical low-hard state (Gallo, Fender & Pooley, 2003; Maccarone, 2003).

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References

\textbf{Chandra Detections of Two Quiescent Black Hole X-Ray Transients}

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1 Summary

Previous measurements of black hole (BH) X-ray transients in quiescence show that the BH systems have X-ray luminosities ranging from \(10^{37}\) to \(10^{39} \text{erg cm}^{-2} \text{s}^{-1}\). (Garcia et al., 2001; Hameury et al., 2000, Orosz et al., 2001), but the accretion rate onto the BH itself is unclear as to the na-
ture of the accretion flow. Although there is currently no consensus on the origin of the quiescent X-ray emission, three emission sites are considered to be viable for at least some systems. The accretion disk, the putative outflow or jet, and the secondary star (although we note that the secondary star is probably not viable for most of the systems).

Using Chandra observations between 2002 August and 2003 February, we have detected the black hole transients V4641 Sgr and XTE J1859+226 in their low luminosity, quiescent states, and obtained the following results:

- \(L_x = 2.3 \times 10^{37} \text{erg cm}^{-2} \text{s}^{-1}\)
- \(L_x = 1.4 \times 10^{37} \text{erg cm}^{-2} \text{s}^{-1}\)

Now, 14 out of the 15 transients with confirmed black holes have measured quiescent luminosities or sensitive upper limits.

3 Quiescent Black Hole Luminosities

The X-ray luminosity (L_x) for the measurements confirmed the transient BH systems are summarized in Figure 3. We include a new low X-ray flux measurement for XTE J1550–564 (Kaaret et al., 2003), which has not been previously considered in the context of studies of quiescent BHs, and we approximate a distance of 5.3 kpc (Orosz et al., 2002) to convert from flux to luminosity. We also include the lowest flux measurements for the recurrent transient GX 339–4 (Kong et al., 2002; Corbel et al., 2003), and we assume a distance of 4 kpc. The median luminosity is \(2 \times 10^{37} \text{erg cm}^{-2} \text{s}^{-1}\) for the 9 systems with previous detections, and the measured luminosities for V4641 Sgr and XTE J1859+226 are consistent with the median.

3 Quiescent Black Hole X-ray Luminosities

The points with error bars mark the 0.3-8 keV luminosities of XTE J1659+226 and V4641 Sgr from our Chandra measurements, assuming distances of 11 kpc and 7 kpc for the two sources, respectively. The diamonds and upper limits are the X-ray luminosities reported for the other 12 BH systems for which quiescent measure-
ments have been possible (Garcia et al., 2001; Hameury et al., 2002; McClintock et al., 2002; Kong et al., 2002; Kaaret et al., 2003; Corbel et al., 2003). The dashed line is the median luminosity for the previous detections.