ally (Narayan & McClintock 2012; Steiner et al. 2013; McClintock et al. 2013, but see Russell et al. 2013).

The two primary means by which black hole spins are measured are 1) X-ray continuum-fitting (Zhang et al. 1997), and 2) modeling relativistic reflection (frequently termed the "Fe-line" method) (Fabian et al. 1989). The single precept which underpins both methods is the monotonic relationship between spin and the radius of the innermost-stable circular orbit (ISCO) for particles orbiting the black hole. Consequently, by determining $R_{\rm ISCO}$, which is presumed to be the inner-radius of the accretion disk, one may directly infer a black hole's angular momentum J, usually expressed as the dimensionless spin parameter,

$$a_* \equiv cJ/GM^2, \qquad 0 \leq |a_*| \leq 1. \qquad (1)$$

The continuum-fitting method – the basis for the work presented here – has been used to estimate the spins of roughly a dozen stellar-mass black holes (e.g., McClintock et al. 2013, and references therein, Middleton et al. 2006; Kolehmainen et al. 2011). In this method, the inner-disk radius is estimated using the thermal, multicolor blackbody continuum emission from the disk (e.g., Novikov & Thorne 1973; Shakura & Sunyaev 1973). The Fe-line method measures $R_{\rm in}$ using the redward extent of relativistic broadening of reflection features in the disk, and has been applied just as widely (e.g., Brenneman & Reynolds 2006; Walton et al. 2012; Reis et al. 2013 and Reynolds 2013 and references therein). Both methods, but especially the Fe-line method, are also being applied to measure the spins of supermassive black holes in active galactic nuclei (AGN). LMC X–3 is ideal for continuum-fitting as it offers a strong, dominantly thermal continuum at nearly all times. However, its spectra accordingly contain very little signal in reflection, and so reflection models cannot constrain spin for this source.

Prior to this investigation, a preliminary estimate of LMC X–3's spin was obtained via a continuum-fitting measurement from a single *BeppoSAX* spectrum by Davis et al. (2006), later bolstered by Kubota et al. (2010). Their results were hampered primarily by the poorly constrained mass available at the time, and so only a rough estimate was possible, $a_* \sim 0.3$. Employing the new and precise mass measurement from Orosz et al. (2014), we revisit LMC X–3's spin determination. Using the largest data set available to us – over a decade of pointed monitoring with (*RXTE*) – we estimate the spin and its uncertainty for LMC X–3 via X-ray continuum fitting.

2. DATA AND ANALYSIS

We replicate the reduction and analysis techniques adopted in Steiner et al. (2010) while considering the *full* set of *RXTE* pointed observations over the mission lifetime. To ensure the most consistent analysis, we only use data for the PCU-2 detector, which has the most stable calibration and was most frequently active. We separate and analyze each segment of continuous exposure, applying a 300 s lower limit. For very long observations, we divide the interval into segments with individual exposure times less than 5000 s. In total, this yields 1598 spectra with an average exposure time and net signal of ~ 2 ks and $\sim 50 \times 10^3$ counts, respectively. The spectra have been background subtracted and corrected for detector dead time.

We fit the data over the energy range 2.8–25 keV and include a 1% systematic error in the count rates in each channel to account for uncertainties in the response of the detector. We use the average PCU-2 spectrum of the Crab to establish our standard absolute flux calibration (Toor & Seward 1974)[8]. For this step, we use the model CRABCOR (Steiner et al. 2010) which rescales the normalization by 9.7% and adjusts the spectral index by $\Delta\Gamma = 0.01$. There is relatively little interstellar absorption, $N_{\rm H} = 4 \times 10^{20}$ cm^{-2} (Page et al. 2003), which is kept fixed during fitting and modeled via TBABS (Wilms et al. 2000).

Errors are everywhere quoted at the 1σ level unless otherwise indicated. For the primary – i.e., thermal disk – component of emission, we use KERRBB2 (McClintock et al. 2013; Davis & Hubeny 2006; Li et al. 2005), which incorporates all relativistic effects and directly solves for spin. The model KERRBB2 assumes that the disk is razor thin and optically thick. To apply KERRBB2 one must specify four external input parameters: black hole mass, disk inclination, distance D and the viscosity parameter α (Shakura & Sunyaev 1973). The Compton power-law component is modeled empirically using SIMPL (Steiner et al. 2009b). Our complete spectral model is expressed as TBABS(SIMPL⊗KERRBB2)×CRABCOR.

As an initial step in the analysis, we fit the full data set to our spectral model using fiducial values for M and i (Section 1) and a distance $D = 48.1 \pm 2.2$ kpc (Orosz et al. 2009), and adopting a viscosity $\alpha = 0.03$. We include limb darkening and returning radiation effects, adopt zero torque at the inner-disk boundary, and make the standard assumption that the black hole's spin axis is aligned with the orbital angular momentum (Steiner & McClintock 2012; McClintock et al. 2013). There are just four free fit parameters: a_*, mass accretion rate $\dot{M}$, photon spectral index Γ, and the scattering fraction $f_{\rm SC}$ (the fraction of disk photons scattered in the corona). We constrained the photon index to lie in the range $\Gamma = 1.5 - 3.5$; the three other parameters are unconstrained.

Subsequent to fitting all of the spectra, we use our initial results to screen out spectra that are unsuitable for the measurement of spin: We reject data for which $f_{\rm SC}$ exceeds 25% (141/1598; see Steiner et al. 2009a). We likewise discard data for which the goodness-of-fit $\chi^2_\nu > 2$ (4/1598), arriving at a sample of 1454 thermal-state spectra. Figure 1 shows a fit to one representative spectrum. The thermal component in red plainly dominates the flux, and our model of a featureless Comptonized disk provides a more-than sufficient fit ($\chi^2_\nu \approx 0.5$), with only four free parameters.

A restriction of KERRBB2 is that it is only applicable to those data firmly in the "thin-disk" limit (scale height $H/R << 1$). The scale-height of the X-ray emitting region of the disk is determined by radiation pressure, itself set by the luminosity. Previous work has demonstrated

[8] We have explored the effects of the variability of the Crab's spectrum (Wilson-Hodge et al. 2011) on our results and find that they are negligible.