Subject: Results for Hydra
From: rlaing@eso.org
Date: Tue, 30 Oct 2007 17:48:12 +0100 (CET)
To: Alan Bridle <abridle@nrao.edu>

Dear Alan

The attached tarball contains my current best structure function plot and model vs observed profiles for Hydra A.

hydra_sf.ps is the structure function plot you have already seen with some additional model curves added. Details:

Pacerman RM data (standard algorithm quite close)
Noise correction
Bright area of N lobe where s/n is high and both RM algorithms agree

Full line: single power law with q = 2.9, includes effects of beam

Dashed line: broken power law with Kolmogorov slope q_high = 11/3 at high frequencies, q_low = 2.5, break frequency = 0.335 arcsec^{-1} (fixed at Vogt & Ensslin's value), corrected for beam

Dotted line: broken power-law model WITHOUT BEAM CORRECTION. Kolmogorov slope q_high = 11/3 at high frequencies, q_low = 3.0, break frequency = 0.335 arcsec^{-1} again. This isn't a valid model, as we know that we have to include the beam, but illustrates what I think V&E got wrong.

My conclusion from this plot is that we cannot exclude a broken power-law model with a Kolmogorov high-freq slope. As in 3C31, a single power-law model (this time without a high-frequency cut-off) apparently gives a slightly better fit, but given the dependence on an imprecise noise correction we shouldn't make much of this. The dotted line is, I think, what Vogt & Ensslin derived by ignoring the effects of the beam. [Incidentally, I think that this spectrum will have to flatten further on larger scales - q_high = 3 is too steep to continue very far].

I think that this quantifies things adequately. I'd like to show this diagram, but I am not sure whether to leave on the dotted line and go into V&E's neglect of the beam. What do you think? show without V&E.

The remaining 4 plots are alternatives. The left-hand panels are always profiles of observed mean and rms RM (cf. Figs 8 & 10 of Taylor & Perley 1993 with different binning). The N lobe (+ separations) uses Pacerman with a noise correction; S lobe (- separations) uses the standard algorithm with no noise correction.

The right-hand panels are for various models. All of these have a double-beta density model as in Wise et al. and a single power-law power spectrum with q = 2.9. The receding lobe will not be modelled that accurately because there will be significant depolarization there.

cavity45.ps: theta = 45 deg, cavities as in Wise et al., modelled as a pair of identical ellipsoids. ←
cavity60.ps: ditto, theta = 60 deg
nocavity45.ps: spherically symmetric gas distribution, no cavities, theta = 45 deg
nocavity60.ps: ditto, theta = 60 deg

None of the models are wonderful representations of the observations, but the cavity model with theta = 45 deg is clearly the closest, I think. I deliberately chose an example which had a suspciously realistic mean profile, of course. The observed rms is surprisingly low close to the nucleus in the receding lobe, and we don't reproduce this, but the observed rms does decrease with distance for r > r_c as expected in that lobe, unlike the corresponding plot for 3C31. Given the difficulty of fitting RM's in that lobe and the significant depolarization, perhaps we should not expect too much. Otherwise, the rms profile is not too bad.

I'd be in favour of showing cavity45.ps as an example, with some fairly cautious words attached. Based on that, I think that trying to model the RM distributions with cavity geometries derived from X-ray observations is quite a promising approach. yes.

Cheers

Robert

hydraplots.tgz	**Content-Description:**	Hydra A plots
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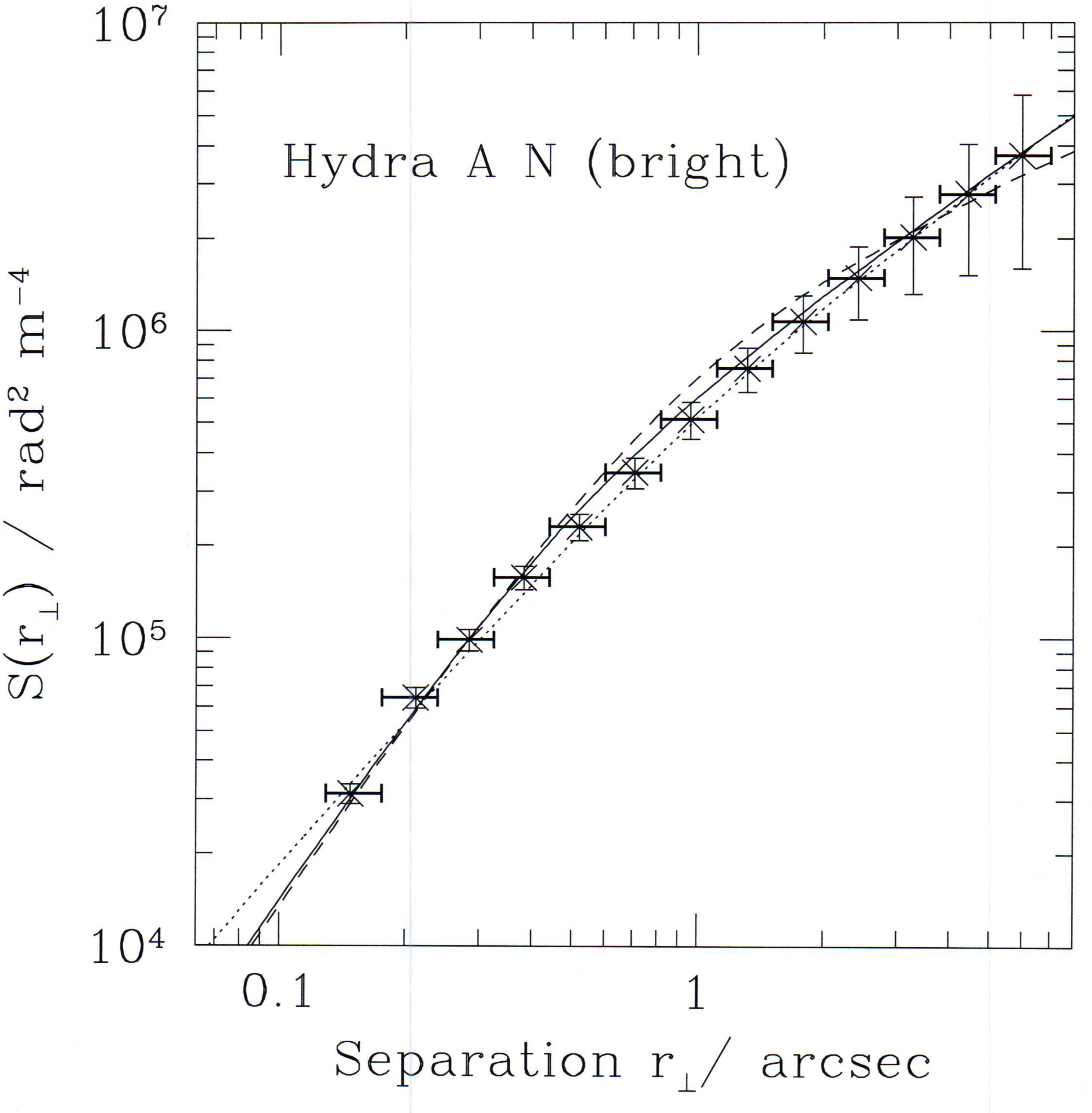
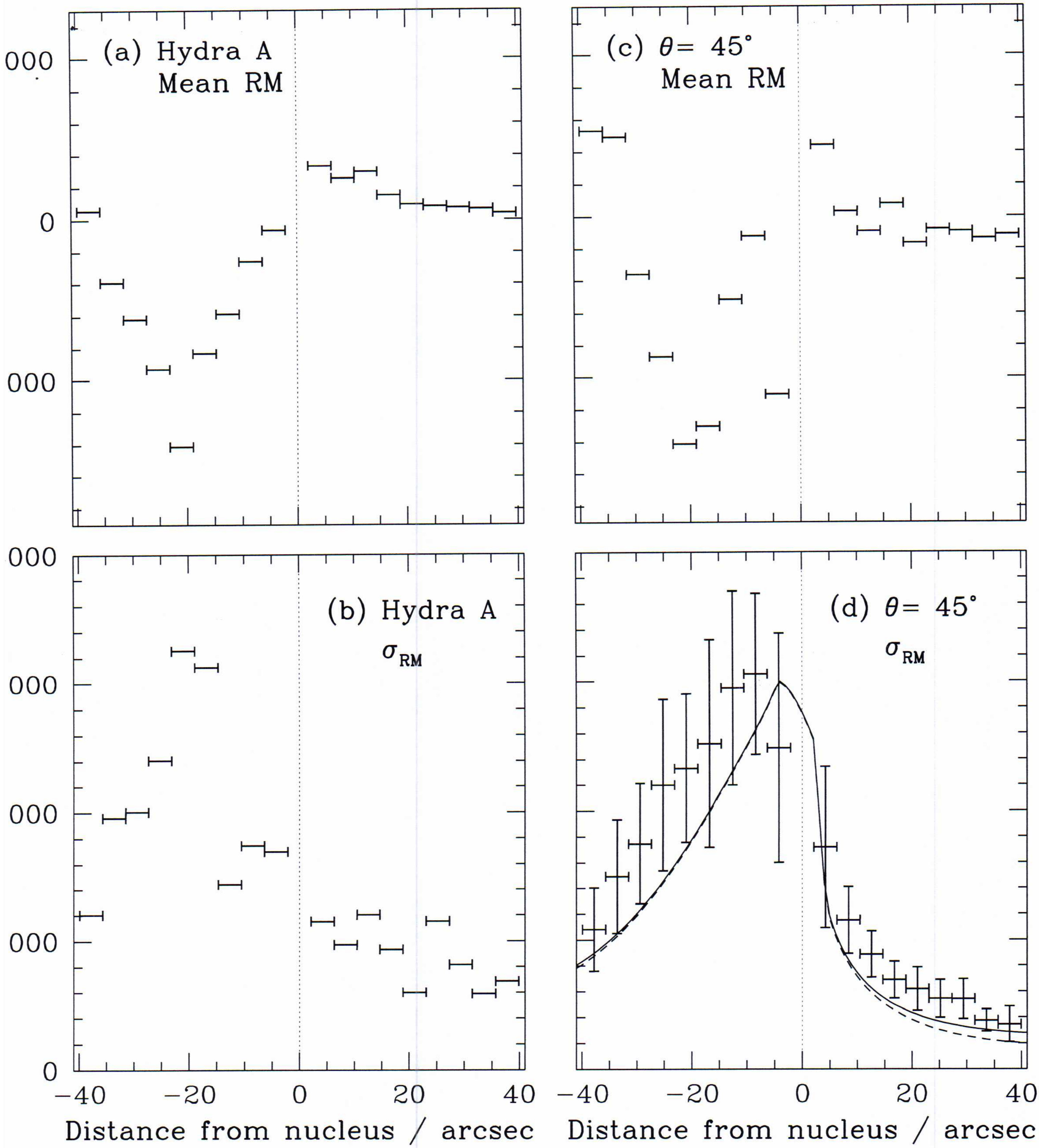
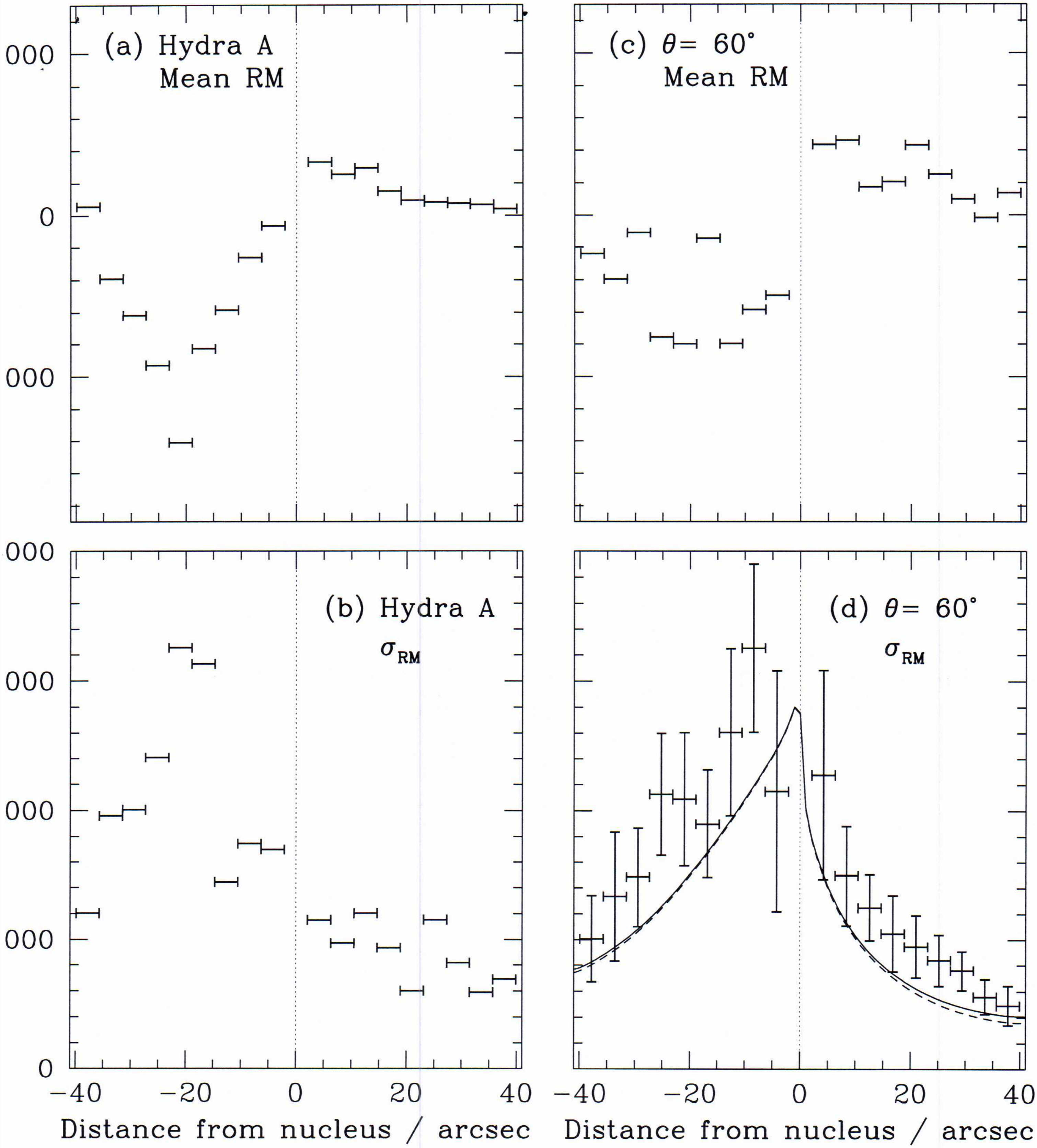


Hydra A N (bright)
$S(r_\perp)$ / rad^2 m^{-4}
10^7
10^6
10^5
10^4
0.1
1
Separation $r_\perp$/ arcsec

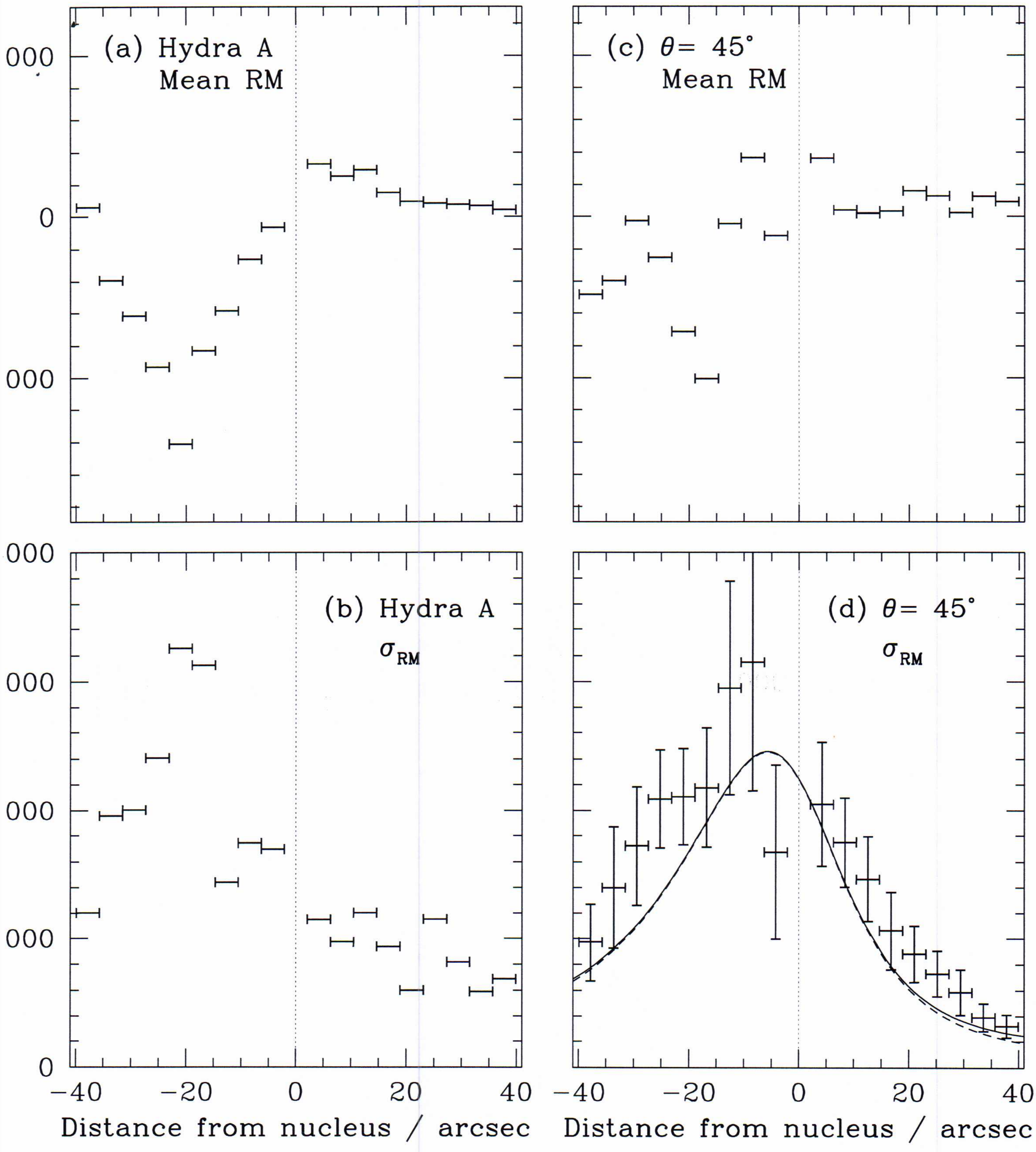

(a) Hydra A
Mean RM
(b) Hydra A
σ_RM
(c) θ= 45°
Mean RM
(d) θ= 45°
σ_RM
000
0
000
000
000
000
000
0
−40
−20
0
20
40
Distance from nucleus / arcsec
Distance from nucleus / arcsec

cavity



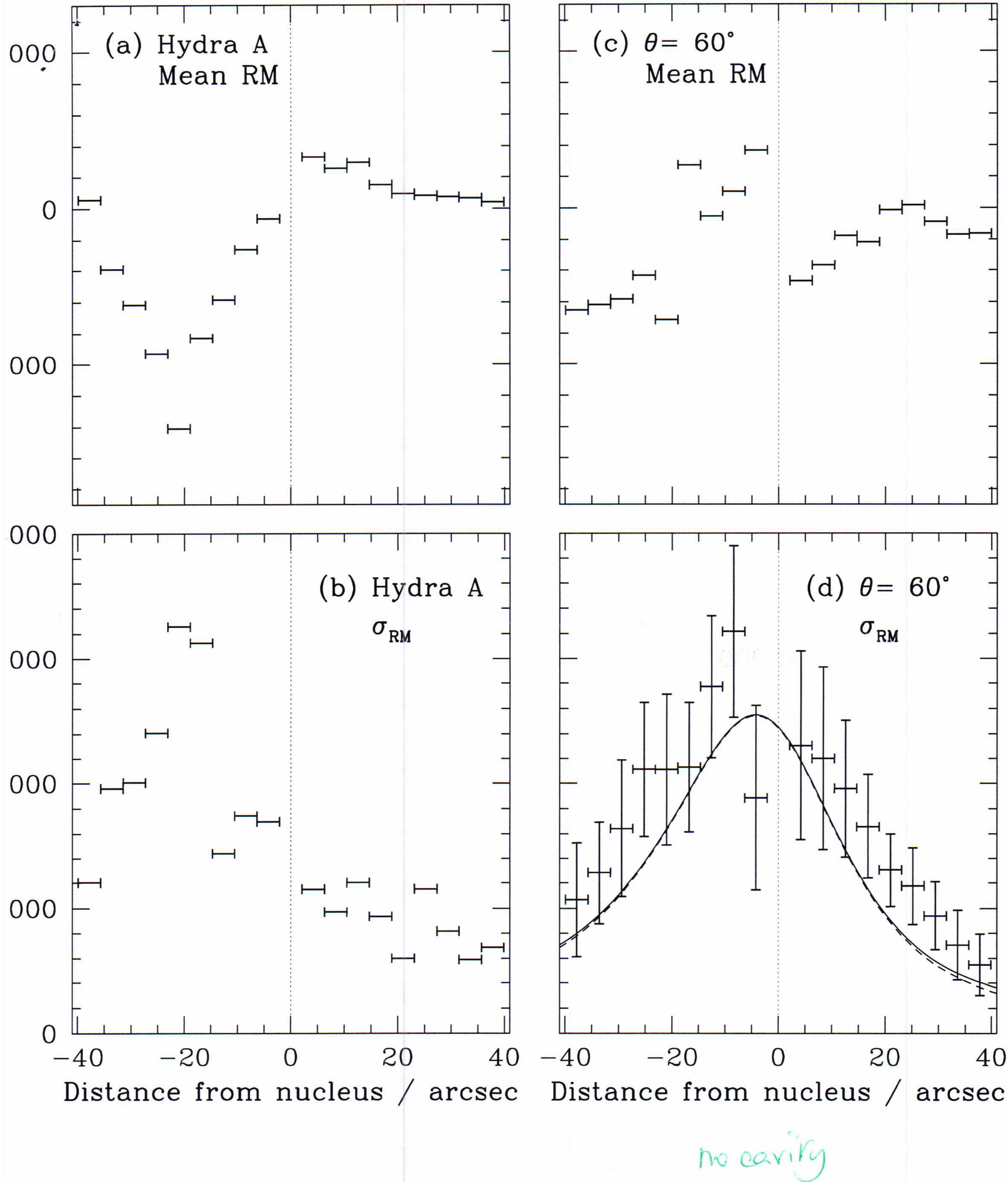
(a) Hydra A
Mean RM
(b) Hydra A
σ_{RM}
(c) θ= 60°
Mean RM
(d) θ= 60°
σ_{RM}
000
0
000
000
000
000
000
0
−40
−20
0
20
40
Distance from nucleus / arcsec
−40
−20
0
20
40
Distance from nucleus / arcsec

cavity



(a) Hydra A
Mean RM
(b) Hydra A
σ_{RM}
(c) θ= 45°
Mean RM
(d) θ= 45°
σ_{RM}
000
0
000
000
000
000
000
0
−40
−20
0
20
40
Distance from nucleus / arcsec
Distance from nucleus / arcsec

no cavity



(a) Hydra A
Mean RM
(b) Hydra A
σ_{RM}
(c) θ= 60°
Mean RM
(d) θ= 60°
σ_{RM}
000
0
000
000
000
000
000
0
−40
−20
0
20
40
Distance from nucleus / arcsec
Distance from nucleus / arcsec
no cavity