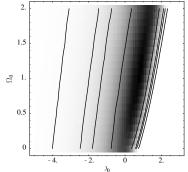
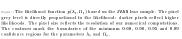
Measuring Cosmological Parameters with the JVAS and **CLASS** Gravitational Lens Surveys

P. Helbig¹, R. D. Blandford², I. W. A. Browne¹, A. G. de Bruyn^{3,4}, C. D. Fassnacht^{2,5}, N. Jackson¹, L. V. E. Koopmans⁴, J. F. Macias-Perez¹, D. R. Marlow^{1,6}, S. T. Myers⁶, R. Quast⁷, D. Rusin⁶, P. N. Wilkinson¹, and E. Xanthopoulos¹

- 1. University of Manchester, Nuffield Radio Astronomy Laboratories, Jodrell Bank

- University of Manchester, Nuffield Radio Astronomy Laboratories, Jodrell Bank
 California Institute of Technology
 Netherlands Foundation for Research in Astronomy, P. O. Box 2, NL-7990 AA Dwingeloo, The Netherlands
 University of Groningen, Kapteyn Astronomical Institute, Postbus 800, NL-9700 AV Groningen, The Netherlands
 NRAO, Socorro
- NRAO, Socorro University of Pennsylvania, Dept. of Physics and Astronomy University of Hamburg, Hamburg Observatory





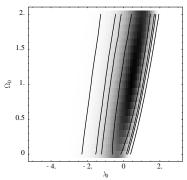
Cosmological constraints from JVAS...

Name	# Images	20 [1]			tens garaxy
B#218+357	2 + ring	0.334	0.6847	0.96	spiral
MG8414+854	4	2.89	0.9584	2.639	elliptical
B1030 + 074	2	1.56	0.599	1.535	spiral
B1422+231	4	1.28	0.337	3.62	7

analysis we are only the nonrece redshift z, and the minome reparation 2.6.

B1933+66 [King et al. 1998] was not included became it is not formula y part of the sample, having a tou terpe port all index and having how recognized on the havin at a formula y part of the sample having a tou terpe port all index and having how recognized on the havin at a few mode of sender and the sample of the

...and optical gravitational lens surveys...



 $r_{\rm dim}$): The same as Fig. 1 but combining JVAS with optical gravitational lens surveys from the literature.

are missed due to extinction in the lens galaxy or to the fact that the typical seeing is not

...and 'reasonably well-accepted wisdom'...

Gravitational lensings statistics alone cannot usefully constrain Ω_2 . Thus, it weems sensible to combine the constraints where in Fig. 2 with measurements of Ω_2 . Facturality, there can be considered as the constraints of the constraint

$$p[\lambda_1, \Omega_1] = L[\Omega_1 | 0.4, 0.2]$$
.

$$p|I_{tc}| = L|I_{tc}|11.5 \text{ Gyr}, 1.3 \text{ Gyr}|$$
,
stimate $H_t = 65 \pm 10 \text{ km s}^{-1} \text{ Mpc}^{-1}$ and choose to formulate this pri

Similarly, we roughly estimate $H_0 = 65.4$ H/km $^{-1}$ Mpc $^{-1}$ and choose to formulate this prior information in form of a normal distribution $p(H_1 = 0.54)$ H/km $^{-1}$ Mpc $^{-1}$ and choose to formulate this prior information in form of a normal distribution $p(H_1 = N)H_1$ [65 km $^{-1}$ Mpc $^{-1}$, 10 km $^{-1}$ Mpc $^{-1}$], = 12

 $p(H_1 - NH_1)$ (since "148"), where, again, the matation for Lioud Ni such that the was argument correspond to the mean and standard deviation.

Fig. 3 shows how inclusions of this prior information, representing a conservative estimate of what we know about the values of the cosmological parameters, tighteen the constraints on λ_1 and λ_2 , are compared to the constraints from lens statistic slaws [Fig. 2, and 1].

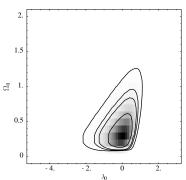
...and the CMB...

... and the UMB...

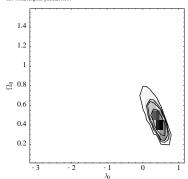
Be has long been realized, Extension et al. 1998) that the direction of degeneracy of countraints from countering from countraints from countraints from countraints from the countraints from the countraints from the countraints from the countraints of the countraints from the countraints from the countraints of the proceeding for the countraints of the countraints of the proceeding forms of the countraints of the countra

\ldots and how this compares to other cosmological tests

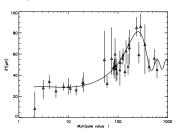
Fig. 4 combine constraints based on optical and radio gravitational lensing statistics, direct measurements of H_0 , Ω_1 and the age of the universe and constraints derived from CMB anisotropies, This restricts λ_1 to a functor range. If me oblives that Ω_1 is Ω_2 , then if follows that λ_1 is Ω_1 denoted by the compared to the result of Derimatter et al., [1993] considerables which λ_1 is Ω_2 is the like of the compared to the result of Derimatter et al., [1994] considerables updated by the considerables which are not large enough in either case to a large, for example, λ_1 is Ω_1 in the solution of the property independent methods. Taken together, prevent measurements of λ_1 from completely independent methods. Taken together, prevent measurements of the monopolity in the constraint $|\lambda_1| = 0$, and $|\lambda_1| = 0$, and $|\lambda_1| = 0$. It is more probably rule out a universe without a commological constant $|\lambda_1| = 0$, and $|\lambda_1| = 0$. It is more inverse in $|\lambda_1| = 0$, and $|\lambda_1| = 0$. It is more invariant and $|\lambda_1| = 0$, and $|\lambda_1| = 0$. It is universe as well. A universe with $\lambda_1| = 0$ and $|\lambda_1| = 0$ is all natural values of the universe.



race is The same as Fig. 2 but combining JWAS and optical gravitational leas surveys from the Stevaters with prior information on the value of Ω_1 , H_1 and the go of the universe. This figure that represents the combination of constraints from leasing statistics and from relatively undisputed knowledge about values of the cosmological parameters.



rane o The same as Fig. 3 but combining JWA5 optical gravitational lens surveys from the literature and prior information on the value of th, H_1 and the age of constraints are more or leve orthogonal to the Irania statistics constraints, this reduces the allowed area of the λ_1 -th parameter space significantly. Note that we scale of this job differs from the previous ones. For technical reasons no models with $k={\rm sign}(\lambda_1+\Omega_1-1)=41$ were calculated; this slightly distorts the contours rare with $k={\rm sign}(\lambda_1+\Omega_1-1)=41$ were calculated; this slightly distorts the contours rare with $k={\rm sign}(\lambda_1+\Omega_1-1)=41$ were calculated; this nightly distorts when the contours rare were $k={\rm contour}$ are $k={\rm contour}$ and $k={\rm contour}$ are $k={\rm contour}$ and $k={\rm contour}$ are $k={\rm contour}$ are $k={\rm contour}$ are $k={\rm contour}$ and $k={\rm contour}$ and $k={\rm contour}$ are $k={\rm contour}$ and $k={\rm contour}$ and $k={\rm contour}$ are $k={\rm contour}$ and $k={\rm contour}$ are $k={\rm contour}$ and $k={\rm contour}$ and $k={\rm contour}$ are $k={\rm contour}$ and $k={\rm contour}$ are $k={\rm contour}$ and $k={\rm contour$



 $r_{\rm spec}$: Power spectrum shown with data points from the literature for our best-fit cosmological model, fitting to the CMB data alone (and keeping parameters other than λ_1 and Ω_1 fixed at predetermined fiducial values).

difference being the lower flux density limit of 200 mJy for JWAS and 30 mJy for CLASS.

However, since CLASS is defined based on never cratalogue. Gift and NYSS-Gregory et al.

100 flux Conduct et al. 100 flux flux JWAS the write libe some creating random differences done to differing quality of shoreval ions and variability of the sources. All the JWAS teres mentioned in Table 1 are in the new CLASS anaphy, which, heiring support flux contributions and variability of the sources. All the JWAS teres in mentioned in Table 1 are in the name CLASS anaphy, which, the primary is unique flux flux flux more market.

Name	# images	$\Delta \theta^{**}$	21	2,	lens galaxy
B07 12+472	4	1.27	0.406	1.34	spiral
B1127+385	2	0.70	?	?	7
B1600+434	2	1.39	0.414	1,589	spiral
B1608+656	4	2 8 8	0.63	1.39	spiral
B 19 33+ 5 87	4 + 4 + 2	1.17	0.755	?	7
B1938+666	4 + 2	0.93	?	7	7
B2845+265	4	1.86	0.867	1.28	7
B2114+022	2 or 4	2.57	0.32 & 0.59	?	?

 $_{\rm Tabe}$:: CLASS gravitational lenses and the two JVAS lens systems (1938+666 and 2114+922) not listed in Table 1.

We hape that the larger size of CLASS will allow the constraints on cosmological parame-ers from gravitational leasing statistics to improve. At present, the greatest uncertainty is the redshif-dependent luminosity function for aquivalently the final-spendent exhibit dis-ributions of the uniformed population which at course, due to the amplification bias, extends of nairer flush-ensiste it has the survey the eff. We are currently taking steps to decrease this control of the survey of the control of the contro



This reserve was supported in part by the European Commission, TAM Programmer, Bowled Newbook Conferent ERRO MINENCE POSITION (INTERNAL CONFERENCE AND ASSESSED ASSES

we have been supported by the property of Period of Peri

Augusto P., Browne I.W.A., Wilkinson P.N., et al., 1999, MNRAS, in preparatio

Bahcall N., Fan X., Cen R., 1997, ApJ, 485, L53
Bahcall N.A., 1998, In: Müller et al., 1998, pp. 137-146, astro-ph/9711062

Bartelmann M., Huss A., Colberg J.M., Jenkins A., Pearce F.R., 1998, A&A, 330, 1

netermina M., 1801 A., Christop J.-M., 2006 M. 1990 F. 2007 F. 2007 A. 2007 M. 1892 M. Brown J. A., 1801 J. 2007 M. 20

Carlberg R.G., Yee H.K.C., Morris S.L., et al., 1998b, Phil. Trans. R. Soc. Lond. A, submitted, a str \sim ph/9805 13 1

Chabowr B., Demaroue P., Kernan P.J., Krauss I.M., 1998, ApJ, 494, 96

Canony B., Demarque P., Artan F.J., Aratus L.M., 1998, AJ, 115, 1693 Condon J.J., Catton W.D., Greisen E.W., et al., 1998, AJ, 115, 1693 Daly R.A., Guerra E.J., Wan L., 1998, In: Thanh & Giraud-Heraud | 1998| astro-ph/9803265

Eisenstein D.J., Hu W., Teemark M., 1998, ApJ, submitted, astro-p/9807130

Kim A.G., 1998, In: Thanh & Graud-Heraud | 1998 | , a str o-ph/9805 196

King L.J., Browne I.W.A., 1996, MNRAS, 282, 67

King L.J., Jackson N.J., Blandford R.D., et al., 1998, MNRAS, 295, L41

Kochanek C S., 1996, ApJ, 466, 638

Container C. S., 1998, ApJ, 1965, L69

Müller V., Gattliffer S., Mickel J.P., Wambeyand J., Jeth. J., 1998, Large Scale Structur:
Tracks and Traces. Proceedings of the 12th Pottsham Cosmology Workshop, Pottsham Cosmology Workshop, Singapore, World Scientific

Perlmutter S., Aldering G., Valle M.D., et al., 1998, Nat, 391, 31
Perlmutter S., Aldering G., Goldhaber G., et al., 1999, ApJ, in press, astroph/9812 133
Ress A.G., Filippenho A.V., Challis P., et al., 1998, AJ, 116, 1009, in press astroph/9812 133

Schmidt B.P., Suntzeff N.B., Phillips M.M., et al., 1998, ApJ, 507, 46

Taylor G.B., Vermeulen R.C., Readhead A.C.S., et al., 1996, ApJS, 107, 37

Wilkinson P.N., Browne L.W.A., Patnaik A.R., Wrobel J., Sorothia B., 1998, MNRAS, in

CERES publications: http://multiwac.jb.man.ac.uk:8000/ceres/papers/papers.html