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## Tracing the Mass-Dependent Star Formation History of Late-Type Galaxies Using X-Ray Emission: Results from the Chandra Deep Fields

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## Abstract

We report on the X-ray evolution over the last  $\sim 9$  Gyr of cosmic history (i.e., since  $z = 1.4$ ) of late-type galaxy populations in the Chandra Deep Field-North and Extended Chandra Deep Field-South (CDF-N and E-CDF-S, respectively; jointly CDFs) survey fields. Our late-type galaxy sample consists of 2568 galaxies, which were identified using rest-frame optical colors and *HST* morphologies. We utilized X-ray stacking analyses to investigate the X-ray emission from these galaxies, emphasizing the contributions from normal galaxies that are not dominated by active galactic nuclei (AGNs). Over this redshift range, we find significant increases (factors of  $\sim 5$ -10) in the X-ray-to-optical mean luminosity ratio ( $L_X/L_B$ ) and the X-ray-to-stellar mass mean ratio ( $L_X/M_*$ ) for galaxy populations selected by  $L_B$  and  $M_*$ , respectively. When analyzing galaxy samples selected via SFR, we find that the mean X-ray-to-SFR ratio ( $L_X/\text{SFR}$ ) is consistent with being constant over the entire redshift range for galaxies with  $\text{SFR} = 1$ -100  $M_\odot \text{yr}^{-1}$ , thus demonstrating that X-ray emission can be used as a robust indicator of star formation activity out to  $z \sim 1.4$ . We find that the star formation activity (as traced by X-ray luminosity) per unit stellar mass in a given redshift bin increases with decreasing stellar mass over the redshift range  $z = 0.2$ -1, which is consistent with previous studies of

how star formation activity depends on stellar mass. Finally, we extend our X-ray analyses to Lyman break galaxies at  $z \sim 3$  and estimate that  $L_X/L_B$  at  $z \sim 3$  is similar to its value at  $z = 1.4$ .




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## References

- [↑](#) Afonso, J., Mobasher, B., Koekemoer, A., Norris, R. P., & Cram, L. 2006, *AJ*, **131**, 1216  
[IOPscience](#)   [ADS](#)
- [↑](#) Alexander, D. M., Ausser, H., Bauer, F. E., Brandt, W. N., Hornschemeier, A. E., Vignali, C., Garmire, G. P., & Schneider, D. P. 2002, *ApJ*, **568**, L85  
[IOPscience](#)   [ADS](#)
- [↑](#) Alexander, D. M., et al. 2003, *AJ*, **126**, 539  
[IOPscience](#)   [ADS](#)
- [↑](#) Alonso-Herrero, A., et al. 2006, *ApJ*, **640**, 167  
[IOPscience](#)   [ADS](#)
- [↑](#) Baldry, I. K., Glazebrook, K., Brinkmann, J., Ivezi, Ž., Lupton, R. H., Nichol, R. C., & Szalay, A. S. 2004, *ApJ*, **600**, 681  
[IOPscience](#)   [ADS](#)
- [↑](#) Barger, A. J., Cowie, L. L., & Wang, W.-H. 2007, *ApJ*, **654**, 764

[IOPscience](#)   [ADS](#)

[↑](#) Barger, A. J., et al. 2003, *AJ*, **126**, 632

[IOPscience](#)   [ADS](#)

[↑](#) Bauer, F. E., Alexander, D. M., Brandt, W. N., Hornschemeier, A. E., Vignali, C., Garmire, G. P., & Schneider, D. P. 2002a, *AJ*, **124**, 2351

[IOPscience](#)   [ADS](#)

[↑](#) Bauer, F. E., Alexander, D. M., Brandt, W. N., Schneider, D. P., Treister, E., Hornschemeier, A. E., & Garmire, G. P. 2004, *AJ*, **128**, 2048

[IOPscience](#)   [ADS](#)

[↑](#) Bauer, F. E., Brandt, W. N., & Lehmer, B. 2003, *AJ*, **126**, 2797

[IOPscience](#)   [ADS](#)

[↑](#) Bauer, F. E., et al. 2002b, *AJ*, **123**, 1163

[IOPscience](#)   [ADS](#)

[↑](#) Bell, E. F. 2003, *ApJ*, **586**, 794

[IOPscience](#)   [ADS](#)

[↑](#) Bell, E. F., & de Jong, R. S. 2001, *ApJ*, **550**, 212

[IOPscience](#)   [ADS](#)

[↑](#) Bell, E. F., McIntosh, D. H., Katz, N., & Weinberg, M. D. 2003, *ApJS*, **149**, 289

[IOPscience](#)   [ADS](#)

[↑](#) Bell, E. F., Zheng, X. Z., Papovich, C., Borch, A., Wolf, C., & Meisenheimer, K. 2007, *ApJ*, **663**, 834

[IOPscience](#)   [ADS](#)

[↑](#) Bell, E. F., et al. 2004a, *ApJ*, **608**, 752

[IOPscience](#)   [ADS](#)

[↑](#) Bell, E. F., et al. 2004b, *ApJ*, **600**, L11

[IOPscience](#)   [ADS](#)

[↑](#) Bell, E. F., et al. 2005, *ApJ*, **625**, 23

[IOPscience](#)   [ADS](#)

[↑](#) Blanton, M. R., et al. 2003, *ApJ*, **594**, 186

[IOPscience](#)   [ADS](#)

[↑](#) Borch, A., et al. 2006, *A&A*, **453**, 869

[Crossref](#)   [ADS](#)

[↑](#) Bouwens, R. J., Illingworth, G. D., Thompson, R. I., & Franx, M. 2005, *ApJ*, **624**, L5

[IOPscience](#)   [ADS](#)

[↑](#) Bouwens, R. J., et al. 2004, *ApJ*, **616**, L79

[IOPscience](#)   [ADS](#)

[↑](#) Brand, K., et al. 2005, *ApJ*, **626**, 723

[IOPscience](#)   [ADS](#)

[↑](#) Brandt, W. N., & Hasinger, G. 2005, *ARA&A*, **43**, 827

[Crossref](#)   [ADS](#)

[↑](#) Brandt, W. N., Hornschemeier, A. E., Schneider, D. P., Alexander, D. M., Bauer, F. E., Garmire, G. P., & Vignali, C. 2001, *ApJ*, **558**, L5

[IOPscience](#)   [ADS](#)

[↑](#) Bundy, K., et al. 2006, *ApJ*, **651**, 120

[IOPscience](#)   [ADS](#)

[↑](#) Caldwell, J. A. R., et al. 2005, *ApJS*, submitted (astro-ph/0510782)

[ADS](#)   [Preprint](#)

[↑](#) Capak, P., et al. 2004, *AJ*, **127**, 180

[IOPscience](#)   [ADS](#)

- [↑](#) Church, M. J., & Balucis-Church, M. 2001, *A&A*, **369**, 915  
[Crossref](#)    [ADS](#)
- [↑](#) Cohen, J. G. 2003, *ApJ*, **598**, 288  
[IOPscience](#)    [ADS](#)
- [↑](#) Colbert, E. J. M., Heckman, T. M., Ptak, A. F., Strickland, D. K., & Weaver, K. A. 2004, *ApJ*, **602**, 231  
[IOPscience](#)    [ADS](#)
- [↑](#) Colbert, J. W., et al. 2006, *ApJ*, **648**, 250  
[IOPscience](#)    [ADS](#)
- [↑](#) Cowie, L. L., Songaila, A., Hu, E. M., & Cohen, J. G. 1996, *AJ*, **112**, 839  
[Crossref](#)    [ADS](#)
- [↑](#) Daddi, E., et al. 2007a, *ApJ*, **670**, 156  
[IOPscience](#)    [ADS](#)
- [↑](#) Daddi, E., et al. 2007b, *ApJ*, **670**, 173  
[IOPscience](#)    [ADS](#)
- [↑](#) Dale, D. A., Helou, G., Contursi, A., Silbermann, N. A., & Kolhatkar, S. 2001, *ApJ*, **549**, 215  
[IOPscience](#)    [ADS](#)
- [↑](#) Davis, M., et al. 2007, *ApJ*, **660**, L1  
[IOPscience](#)    [ADS](#)
- [↑](#) de Vaucouleurs, G., de Vaucouleurs, A., Corwin, H. G., Buta, R. J., Paturel, G., & Fouque, P. 1991, *Third Reference Catalog of Bright Galaxies* (Berlin: Springer)
- [↑](#) Dickinson, M., et al. 2004, *ApJ*, **600**, L99  
[IOPscience](#)    [ADS](#)

- [↑](#) Doane, N. E., Sanders, W. T., Wilcots, E. M., & Juda, M. 2004, *AJ*, **128**, 2712  
[IOPscience](#)    [ADS](#)
- [↑](#) Donley, J. L., Rieke, G. H., Pérez-González, P. G., Rigby, J. R., & Alonso-Herrero, A. 2007, *ApJ*, **660**, 167  
[IOPscience](#)    [ADS](#)
- [↑](#) Fabbiano, G. 1989, *ARA&A*, **27**, 87  
[Crossref](#)    [ADS](#)
- [↑](#) Fabbiano, G. 2006, *ARA&A*, **44**, 323  
[Crossref](#)    [ADS](#)
- [↑](#) Fabbiano, G., Kim, D.-W., & Trinchieri, G. 1992, *ApJS*, **80**, 531  
[Crossref](#)    [ADS](#)
- [↑](#) Fabbiano, G., & Shapley, A. 2002, *ApJ*, **565**, 908  
[IOPscience](#)    [ADS](#)
- [↑](#) Faber, S. M., et al. 2007, *ApJ*, **665**, 265  
[IOPscience](#)    [ADS](#)
- [↑](#) Fazio, G. G., et al. 2004, *ApJS*, **154**, 10  
[IOPscience](#)    [ADS](#)
- [↑](#) Floc, M., & Rocca-Volmerange, B. 1997, *A&A*, **326**, 950  
[ADS](#)
- [↑](#) Freeman, P. E., Kashyap, V., Rosner, R., & Lamb, D. Q. 2002, *ApJS*, **138**, 185  
[IOPscience](#)    [ADS](#)
- [↑](#) Gawiser, E., et al. 2006, *ApJS*, **162**, 1  
[IOPscience](#)    [ADS](#)
- [↑](#) Georgakakis, A., Georgantopoulos, I., Stewart, G. C., Shanks, T., & Boyle, B. J. 2003, *MNRAS*, **344**, 161



[Crossref](#)   [ADS](#)

[↑](#) Georgakakis, A., Rowan-Robinson, M., Babbedge, T. S. R., & Georgantopoulos, I. 2007, *MNRAS*, **377**, 203

[Crossref](#)   [ADS](#)

[↑](#) Georgantopoulos, I., Georgakakis, A., & Koulouridis, E. 2005, *MNRAS*, **360**, 782

[Crossref](#)   [ADS](#)

[↑](#) Ghosh, P., & White, N. E. 2001, *ApJ*, **559**, L97

[IOPscience](#)   [ADS](#)

[↑](#) Giacconi, R., et al. 2002, *ApJS*, **139**, 369

[IOPscience](#)   [ADS](#)

[↑](#) Giavalisco, M. 2002, *ARA&A*, **40**, 579

[Crossref](#)   [ADS](#)

[↑](#) Giavalisco, M., et al. 2004a, *ApJ*, **600**, L93

[IOPscience](#)   [ADS](#)

[↑](#) Giavalisco, M., et al. 2004b, *ApJ*, **600**, L103

[IOPscience](#)   [ADS](#)

[↑](#) Gilfanov, M. 2004, *MNRAS*, **349**, 146

[Crossref](#)   [ADS](#)

[↑](#) Gilfanov, M., Grimm, H.-J., & Sunyaev, R. 2004a, *Nucl. Phys. B Proc. Suppl.*, **132**, 369

[Crossref](#)   [ADS](#)

[↑](#) Gilfanov, M., Grimm, H.-J., & Sunyaev, R. 2004b, *MNRAS*, **347**, L57

[Crossref](#)   [ADS](#)

[↑](#) Gilli, R., et al. 2003, *ApJ*, **592**, 721

[IOPscience](#)   [ADS](#)

[↑](#) Gilmore, G., King, I., & van der Kruit, P. 1990, *The Milky Way as a Galaxy* (Sausalito: University Science Books)

[↑](#) Grazian, A., et al. 2006, *A&A*, **449**, 951

[Crossref](#)   [ADS](#)

[↑](#) Grimm, H.-J., Gilfanov, M., & Sunyaev, R. 2002, *A&A*, **391**, 923

[Crossref](#)   [ADS](#)

[↑](#) Grimm, H.-J., Gilfanov, M., & Sunyaev, R. 2003, *MNRAS*, **339**, 793

[Crossref](#)   [ADS](#)

[↑](#) Hammer, F., Puech, M., Chemin, L., Flores, H., & Lehnert, M. D. 2007, *ApJ*, **662**, 322

[IOPscience](#)   [ADS](#)

[↑](#) Häussler, B., et al. 2007, *ApJS*, **172**, 615

[IOPscience](#)   [ADS](#)

[↑](#) Hogg, D. W., Baldry, I. K., Blanton, M. R., & Eisenstein, D. J. 2002a, *preprint* astro-ph/0210394

[ADS](#)   [Preprint](#)

[↑](#) Hogg, D. W., et al. 2002b, *AJ*, **124**, 646

[IOPscience](#)   [ADS](#)

[↑](#) Hogg, D. W., et al. 2004, *ApJ*, **601**, L29

[IOPscience](#)   [ADS](#)

[↑](#) Hopkins, A. M. 2004, *ApJ*, **615**, 209

[IOPscience](#)   [ADS](#)

[↑](#) Hornschemeier, A. E., et al. 2000, *ApJ*, **541**, 49

[IOPscience](#)   [ADS](#)

- [↑](#) Hornschemeier, A. E., et al. 2002, *ApJ*, **568**, 82 (H02)  
[IOPscience](#)    [ADS](#)
- [↑](#) Hornschemeier, A. E., et al. 2003, *AJ*, **126**, 575  
[IOPscience](#)    [ADS](#)
- [↑](#) Irwin, J. A., Athey, A. E., & Bregman, J. N. 2003, *ApJ*, **587**, 356  
[IOPscience](#)    [ADS](#)
- [↑](#) Isobe, T., & Feigelson, E. 1990, *BAAS*, **22**, 917  
[ADS](#)
- [↑](#) Jenkins, L. P., Roberts, T. P., Ward, M. J., & Zezas, A. 2005, *MNRAS*, **357**, 109  
[Crossref](#)    [ADS](#)
- [↑](#) Juneau, S., et al. 2005, *ApJ*, **619**, L135  
[IOPscience](#)    [ADS](#)
- [↑](#) Kauffmann, G., et al. 2003a, *MNRAS*, **341**, 54  
[Crossref](#)    [ADS](#)
- [↑](#) Kauffmann, G., et al. 2003b, *MNRAS*, **346**, 1055  
[Crossref](#)    [ADS](#)
- [↑](#) Kennicutt, R. C., Jr. 1998, *ARA&A*, **36**, 189  
[Crossref](#)    [ADS](#)
- [↑](#) Kilgard, R. E., et al. 2005, *ApJS*, **159**, 214  
[IOPscience](#)    [ADS](#)
- [↑](#) Kim, D.-W., et al. 2006, *ApJ*, **644**, 829  
[IOPscience](#)    [ADS](#)
- [↑](#) Kroupa, P. 2001, *MNRAS*, **322**, 231

[Crossref](#)    [ADS](#)

[↑](#) Kroupa, P., Tout, C. A., & Gilmore, G. 1993, *MNRAS*, **262**, 545

[Crossref](#)    [ADS](#)

[↑](#) Labbé, I., et al. 2007, *ApJ*, **665**, 944

[IOPscience](#)    [ADS](#)

[↑](#) Laird, E. S., Nandra, K., Adelberger, K. L., Steidel, C. C., & Reddy, N. A. 2005, *MNRAS*, **359**, 47

[Crossref](#)    [ADS](#)

[↑](#) Laird, E. S., Nandra, K., Hobbs, A., & Steidel, C. C. 2006, *MNRAS*, **373**, 217

[Crossref](#)    [ADS](#)

[↑](#) Lavalley, M., Isobe, T., & Feigelson, E. 1992, in *ASP Conf. Ser. 25, Astronomical Data Analysis Software and Systems I*, ed. D. M. Worrall, C. Biemesderfer, & J. Barnes (San Francisco: ASP), 245

[ADS](#)

[↑](#) Lee, K.-S., Giavalisco, M., Gnedin, O. Y., Somerville, R. S., Ferguson, H. C., Dickinson, M., & Ouchi, M. 2006, *ApJ*, **642**, 63

[IOPscience](#)    [ADS](#)

[↑](#) Le Fèvre, O., et al. 2004, *A&A*, **428**, 1043

[Crossref](#)    [ADS](#)

[↑](#) Lehmer, B. D., et al. 2005a, *AJ*, **129**, 1

[IOPscience](#)    [ADS](#)

[↑](#) Lehmer, B. D., et al. 2005b, *ApJS*, **161**, 21

[IOPscience](#)    [ADS](#)

[↑](#) Lehmer, B. D., et al. 2006, *AJ*, **131**, 2394

[IOPscience](#)    [ADS](#)

- [↑](#) Lehmer, B. D., et al. 2007, *ApJ*, **657**, 681  
[IOPscience](#)   [ADS](#)
- [↑](#) Lilly, S. J., Le Fevre, O., Hammer, F., & Crampton, D. 1996, *ApJ*, **460**, L1  
[IOPscience](#)   [ADS](#)
- [↑](#) Lilly, S. J., Tresse, L., Hammer, F., Crampton, D., & Le Fevre, O. 1995, *ApJ*, **455**, 108  
[Crossref](#)   [ADS](#)
- [↑](#) Lira, P., Ward, M. J., Zezas, A., & Murray, S. S. 2002, *MNRAS*, **333**, 709  
[Crossref](#)   [ADS](#)
- [↑](#) Liu, Q. Z., & Mirabel, I. F. 2005, *A&A*, **429**, 1125  
[Crossref](#)   [ADS](#)
- [↑](#) Liu, Q. Z., van Paradijs, J., & van den Heuvel, E. P. J. 2006, *A&A*, **455**, 1165  
[Crossref](#)   [ADS](#)
- [↑](#) Lockman, F. J. 2004, *Soft X-Ray Emission from Clusters of Galaxies and Related Phenomena*, ed. R. Lieu (Dordrecht: Kluwer), 111  
[Crossref](#)   [ADS](#)
- [↑](#) Lonsdale, C. J., et al. 2003, *PASP*, **115**, 897  
[IOPscience](#)   [ADS](#)
- [↑](#) Maccacaro, T., Gioia, I. M., Wolter, A., Zamorani, G., & Stocke, J. T. 1988, *ApJ*, **326**, 680  
[Crossref](#)   [ADS](#)
- [↑](#) Madau, P., Ferguson, H. C., Dickinson, M. E., Giavalisco, M., Steidel, C. C., & Fruchter, A. 1996, *MNRAS*, **283**, 1388  
[Crossref](#)   [ADS](#)
- [↑](#) McIntosh, D. H., et al. 2005, *ApJ*, **632**, 191  
[IOPscience](#)   [ADS](#)

- [↑](#) McKee, C. F., & Williams, J. P. 1997, *ApJ*, **476**, 144  
[IOPscience](#)    [ADS](#)
- [↑](#) Mignoli, M., et al. 2005, *A&A*, **437**, 883  
[Crossref](#)    [ADS](#)
- [↑](#) Mobasher, B., et al. 2004, *ApJ*, **600**, L167  
[IOPscience](#)    [ADS](#)
- [↑](#) Moran, E. C., Filippenko, A. V., & Chornock, R. 2002, *ApJ*, **579**, L71  
[IOPscience](#)    [ADS](#)
- [↑](#) Moy, E., Barmby, P., Rigopoulou, D., Huang, J.-S., Willner, S. P., & Fazio, G. G. 2003, *A&A*, **403**, 493  
[Crossref](#)    [ADS](#)
- [↑](#) Murray, S. S., et al. 2005, *ApJS*, **161**, 1  
[IOPscience](#)    [ADS](#)
- [↑](#) Nandra, K., Mushotzky, R. F., Arnaud, K., Steidel, C. C., Adelberger, K. L., Gardner, J. P., Teplitz, H. I., & Windhorst, R. A. 2002, *ApJ*, **576**, 625  
[IOPscience](#)    [ADS](#)
- [↑](#) Nandra, K., et al. 2005, *MNRAS*, **356**, 568  
[Crossref](#)    [ADS](#)
- [↑](#) Nandra, K., et al. 2007, *ApJ*, **660**, L11  
[IOPscience](#)    [ADS](#)
- [↑](#) Noeske, K. G., et al. 2007a, *ApJ*, **660**, L43  
[IOPscience](#)    [ADS](#)
- [↑](#) Noeske, K. G., et al. 2007b, *ApJ*, **660**, L47  
[IOPscience](#)    [ADS](#)

[↑](#) Norman, C., et al. 2004, *ApJ*, **607**, 721

[IOPscience](#)   [ADS](#)

[↑](#) Olsen, L. F., et al. 2006, *A&A*, **456**, 881

[Crossref](#)   [ADS](#)

[↑](#) Papovich, C., & Bell, E. F. 2002, *ApJ*, **579**, L1

[IOPscience](#)   [ADS](#)

[↑](#) Peng, C. Y., Ho, L. C., Impey, C. D., & Rix, H.-W. 2002, *AJ*, **124**, 266

[IOPscience](#)   [ADS](#)

[↑](#) Pérez-González, P. G., et al. 2005, *ApJ*, **630**, 82

[IOPscience](#)   [ADS](#)

[↑](#) Persic, M., & Rephaeli, Y. 2007, *A&A*, **463**, 481 (PR07)

[Crossref](#)   [ADS](#)

[↑](#) Persic, M., Rephaeli, Y., Braito, V., Cappi, M., Della Ceca, R., Franceschini, A., & Gruber, D. E. 2004, *A&A*, **419**, 849

[Crossref](#)   [ADS](#)

[↑](#) Peterson, K. C., Gallagher, S. C., Hornschemeier, A. E., Munro, M. P., & Bullard, E. C. 2006, *AJ*, **131**, 133

[IOPscience](#)   [ADS](#)

[↑](#) Ptak, A., Griffiths, R., White, N., & Ghosh, P. 2001, *ApJ*, **559**, L91

[IOPscience](#)   [ADS](#)

[↑](#) Ptak, A., Mobasher, B., Hornschemeier, A., Bauer, F., & Norman, C. 2007, *ApJ*, **667**, 826

[IOPscience](#)   [ADS](#)

[↑](#) Ranalli, P., Comastri, A., & Setti, G. 2003, *A&A*, **399**, 39

[Crossref](#)   [ADS](#)

- [↑](#) Ravikumar, C. D., et al. 2007, *A&A*, **465**, 1099  
[Crossref](#)    [ADS](#)
- [↑](#) Reddy, N. A., & Steidel, C. C. 2004, *ApJ*, **603**, L13  
[IOPscience](#)    [ADS](#)
- [↑](#) Richards, E. A., Kellermann, K. I., Fomalont, E. B., Windhorst, R. A., & Partridge, R. B. 1998, *AJ*, **116**, 1039  
[IOPscience](#)    [ADS](#)
- [↑](#) Rieke, G. H., et al. 2004, *ApJS*, **154**, 25  
[IOPscience](#)    [ADS](#)
- [↑](#) Rix, H., et al. 2004, *ApJS*, **152**, 163  
[IOPscience](#)    [ADS](#)
- [↑](#) Rosa-González, D., Burgarella, D., Nandra, K., Kunth, D., Terlevich, E., & Terlevich, R. 2007, *MNRAS*, **379**, 357  
[Crossref](#)    [ADS](#)
- [↑](#) Rovilos, E., Georgakakis, A., Georgantopoulos, I., Afonso, J., Koekemoer, A. M., Mobasher, B., & Goudis, C. 2007, *A&A*, **466**, 119  
[Crossref](#)    [ADS](#)
- [↑](#) Sanders, D. B., Mazzarella, J. M., Kim, D.-C., Surace, J. A., & Soifer, B. T. 2003, *AJ*, **126**, 1607  
[IOPscience](#)    [ADS](#)
- [↑](#) Sasaki, M., Pietsch, W., & Haberl, F. 2003, *A&A*, **403**, 901  
[Crossref](#)    [ADS](#)
- [↑](#) Schiminovich, D., et al. 2005, *ApJ*, **619**, L47  
[IOPscience](#)    [ADS](#)
- [↑](#) Schmitt, H. R., Calzetti, D., Armus, L., Giavalisco, M., Heckman, T. M., Kennicutt, R. C., Jr., Leitherer, C., & Meurer, G. R. 2006, *ApJ*, **643**, 173



[IOPscience](#)   [ADS](#)

[↑](#) Scoville, N., et al. 2007, *ApJS*, **172**, 1

[IOPscience](#)   [ADS](#)

[↑](#) Shapley, A., Fabbiano, G., & Eskridge, P. B. 2001, *ApJS*, **137**, 139 (S01)

[IOPscience](#)   [ADS](#)

[↑](#) Shen, S., Mo, H. J., White, S. D. M., Blanton, M. R., Kauffmann, G., Voges, W., Brinkmann, J., & Csabai, I. 2003, *MNRAS*, **343**, 978

[Crossref](#)   [ADS](#)

[↑](#) Silverman, J. D., et al. 2008, *ApJ*, **675**, 1025

[IOPscience](#)   [ADS](#)

[↑](#) Snellen, I. A. G., & Best, P. N. 2001, *MNRAS*, **328**, 897

[Crossref](#)   [ADS](#)

[↑](#) Soria, R., & Wu, K. 2003, *A&A*, **410**, 53

[Crossref](#)   [ADS](#)

[↑](#) Spergel, D. N., et al. 2003, *ApJS*, **148**, 175

[IOPscience](#)   [ADS](#)

[↑](#) Stark, A. A., Gammie, C. F., Wilson, R. W., Bally, J., Linke, R. A., Heiles, C., & Hurwitz, M. 1992, *ApJS*, **79**, 77

[Crossref](#)   [ADS](#)

[↑](#) Steffen, A. T., Brandt, W. N., Alexander, D. M., Gallagher, S. C., & Lehmer, B. D. 2007, *ApJ*, **667**, L25

[IOPscience](#)   [ADS](#)

[↑](#) Steidel, C. C., Adelberger, K. L., Giavalisco, M., Dickinson, M., & Pettini, M. 1999, *ApJ*, **519**, 1

[IOPscience](#)   [ADS](#)

[↑](#) Strateva, I., et al. 2001, *AJ*, **122**, 1861

[IOPscience](#)   [ADS](#)

[↑](#) Swartz, D. A., Ghosh, K. K., McCollough, M. L., Pannuti, T. G., Tennant, A. F., & Wu, K. 2003, *ApJS*, **144**, 213

[IOPscience](#)   [ADS](#)

[↑](#) Szokoly, G. P., et al. 2004, *ApJS*, **155**, 271

[IOPscience](#)   [ADS](#)

[↑](#) Tozzi, P., et al. 2006, *A&A*, **451**, 457

[Crossref](#)   [ADS](#)

[↑](#) Tzanavaris, P., & Georgantopoulos, I. 2008, *A&A*, in press (0801.4381)

[ADS](#)   [Preprint](#)

[↑](#) Tzanavaris, P., Georgantopoulos, I., & Georgakakis, A. 2006, *A&A*, **454**, 447

[Crossref](#)   [ADS](#)

[↑](#) Vanzella, E., et al. 2005, *A&A*, **434**, 53

[Crossref](#)   [ADS](#)

[↑](#) Vanzella, E., et al. 2006, *A&A*, **454**, 423

[Crossref](#)   [ADS](#)

[↑](#) Wirth, G. D., et al. 2004, *AJ*, **127**, 3121

[IOPscience](#)   [ADS](#)

[↑](#) Wolf, C., Meisenheimer, K., Rix, H.-W., Borch, A., Dye, S., & Kleinheinrich, M. 2003, *A&A*, **401**, 73

[Crossref](#)   [ADS](#)

[↑](#) Wolf, C., et al. 2004, *A&A*, **421**, 913

[Crossref](#)   [ADS](#)

- [↑](#) Zezas, A., Fabbiano, G., Rots, A. H., & Murray, S. S. 2002, *ApJS*, **142**, 239  
[IOPscience](#)   [ADS](#)
- [↑](#) Zezas, A., Ward, M. J., & Murray, S. S. 2003, *ApJ*, **594**, L31  
[IOPscience](#)   [ADS](#)
- [↑](#) Zheng, X. Z., Bell, E. F., Papovich, C., Wolf, C., Meisenheimer, K., Rix, H.-W., Rieke, G. H., & Somerville, R. 2007, *ApJ*, **661**, L41  
[IOPscience](#)   [ADS](#)

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## Citations

1. X-Ray Spectral Analyses of AGNs from the 7Ms *Chandra* Deep Field-South Survey: The Distribution, Variability, and Evolutions of AGN Obscuration  
Teng Liu *et al.* 2017 *The Astrophysical Journal Supplement Series* **232** 8  
[IOPscience](#)
2. The FMOS-COSMOS Survey of Star-forming Galaxies at  $z \sim 1.6$ . IV. Excitation State and Chemical Enrichment of the Interstellar Medium  
D. Kashino *et al.* 2017 *The Astrophysical Journal* **835** 88  
[IOPscience](#)
3. Chandra ACIS Survey of X-Ray Point Sources in Nearby Galaxies. II. X-Ray Luminosity Functions and Ultraluminous X-Ray Sources  
Song Wang *et al.* 2016 *The Astrophysical Journal* **829** 20  
[IOPscience](#)
4. The Evolution of Normal Galaxy X-Ray Emission through Cosmic History: Constraints from the 6 MS *Chandra* Deep Field-South  
B. D. Lehmer *et al.* 2016 *The Astrophysical Journal* **825** 7  
[IOPscience](#)
5. H Imaging of Nearby Seyfert Host Galaxies

[IOPscience](#)

6. Exploring the Overabundance of ULXs in Metal- and Dust-poor Local Lyman Break Analogs  
Antara R. Basu-Zych *et al.* 2016 *The Astrophysical Journal* **818** 140  
[IOPscience](#)
7. Exploring X-Ray Binary Populations in Compact Group Galaxies with Chandra  
P. Tzanavaris *et al.* 2016 *The Astrophysical Journal* **817** 95  
[IOPscience](#)
8. The 0.3-30 keV Spectra of Powerful Starburst Galaxies: NuSTAR and Chandra Observations of NGC 3256 and NGC 3310  
B. D. Lehmer *et al.* 2015 *The Astrophysical Journal* **806** 126  
[IOPscience](#)
9. X-Ray Properties of K-selected Galaxies at  $0.5 < z < 2.0$ : Investigating Trends with Stellar Mass, Redshift and Spectral Type  
Therese M. Jones *et al.* 2014 *The Astrophysical Journal* **783** 25  
[IOPscience](#)
10. The X-Ray Zurich Environmental Study (X-ZENS). I. Chandra and XMM-Newton Observations of Active Galactic Nuclei in Galaxies in nearby Groups  
J. D. Silverman *et al.* 2014 *The Astrophysical Journal* **780** 67  
[IOPscience](#)
11. An ALMA Survey of Submillimeter Galaxies in the Extended Chandra Deep Field-South: The AGN Fraction and X-Ray Properties of Submillimeter Galaxies  
S. X. Wang *et al.* 2013 *The Astrophysical Journal* **778** 179  
[IOPscience](#)
12. Evidence for Elevated X-Ray Emission in Local Lyman Break Galaxy Analogs  
Antara R. Basu-Zych *et al.* 2013 *The Astrophysical Journal* **774** 152  
[IOPscience](#)
13. A Generalized Power-law Diagnostic for Infrared Galaxies at  $z > 1$ : Active Galactic Nuclei and Hot Interstellar Dust  
K. I. Caputi 2013 *The Astrophysical Journal* **768** 103

[IOPscience](#)

14. Modeling the Redshift Evolution of the Normal Galaxy X-Ray Luminosity Function

M. Tremmel *et al.* 2013 *The Astrophysical Journal* **766** 19

[IOPscience](#)

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B. D. Lehmer *et al.* 2013 *The Astrophysical Journal* **765** 87

[IOPscience](#)

16. X-Ray Binary Evolution Across Cosmic Time

T. Fragos *et al.* 2013 *The Astrophysical Journal* **764** 41

[IOPscience](#)

17. The X-Ray Star Formation Story as Told by Lyman Break Galaxies in the 4 Ms CDF-S

Antara R. Basu-Zych *et al.* 2013 *The Astrophysical Journal* **762** 45

[IOPscience](#)

18. The 4 Ms Chandra Deep Field-South Number Counts Apportioned by Source Class: Pervasive Active Galactic Nuclei and the Ascent of Normal Galaxies

B. D. Lehmer *et al.* 2012 *The Astrophysical Journal* **752** 46

[IOPscience](#)

19. Panchromatic Estimation of Star Formation Rates in BzK Galaxies at  $1 < z < 3$   
Peter Kurczynski *et al.* 2012 *The Astrophysical Journal* **750** 117

[IOPscience](#)

20. Identifying Luminous Active Galactic Nuclei in Deep Surveys: Revised IRAC Selection Criteria

J. L. Donley *et al.* 2012 *The Astrophysical Journal* **748** 142

[IOPscience](#)

21. Variability-selected Low-luminosity Active Galactic Nuclei in the 4 Ms Chandra Deep Field-South

M. Young *et al.* 2012 *The Astrophysical Journal* **748** 124

[IOPscience](#)

22. The Faintest X-Ray Sources from  $z = 0$  TO 8  
L. L. Cowie *et al.* 2012 *The Astrophysical Journal* **748** 50  
[IOPscience](#)
23. X-Ray Constraints on the Ly Escape Fraction  
Zhen-Ya Zheng *et al.* 2012 *The Astrophysical Journal* **746** 28  
[IOPscience](#)
24. The Chandra Deep Field-South Survey: 4 Ms Source Catalogs  
Y. Q. Xue *et al.* 2011 *The Astrophysical Journal Supplement Series* **195** 10  
[IOPscience](#)
25. The OPTX Project. V. Identifying Distant Active Galactic Nuclei  
L. Trouille *et al.* 2011 *The Astrophysical Journal* **742** 46  
[IOPscience](#)
26. Supermassive Black Hole Growth in Starburst Galaxies over Cosmic Time:  
Constraints from the Deepest Chandra Fields  
D. A. Rafferty *et al.* 2011 *The Astrophysical Journal* **742** 3  
[IOPscience](#)
27. Environmentally Driven Global Evolution of Galaxies  
Renyue Cen 2011 *The Astrophysical Journal* **741** 99  
[IOPscience](#)
28. A Search for Lyman Break Galaxies in the Chandra Deep Field South Using  
Swift Ultraviolet/Optical Telescope  
Antara R. Basu-Zych *et al.* 2011 *The Astrophysical Journal* **739** 98  
[IOPscience](#)
29. X-Ray Spectral Constraints for  $z \geq 2$  Massive Galaxies: The Identification of  
Reflection-dominated Active Galactic Nuclei  
D. M. Alexander *et al.* 2011 *The Astrophysical Journal* **738** 44  
[IOPscience](#)
30. The Contribution of X-ray Binaries to the Evolution of Late-type Galaxies:  
Evolutionary Population Synthesis Simulations  
Zhao-Yu Zuo and Xiang-Dong Li 2011 *The Astrophysical Journal* **733** 5  
[IOPscience](#)

31. The Extended Chandra Deep Field-South Survey: Optical Spectroscopy of Faint X-ray Sources with the VLT and Keck  
J. D. Silverman *et al.* 2010 *The Astrophysical Journal Supplement Series* **191** 124  
[IOPscience](#)
32. A Chandra Perspective on Galaxy-wide X-ray Binary Emission and its Correlation with Star Formation Rate and Stellar Mass: New Results from Luminous Infrared Galaxies  
B. D. Lehmer *et al.* 2010 *The Astrophysical Journal* **724** 559  
[IOPscience](#)
33. The Field X-ray AGN Fraction to  $z = 0.7$  from the Chandra Multiwavelength Project and the Sloan Digital Sky Survey  
Daryl Haggard *et al.* 2010 *The Astrophysical Journal* **723** 1447  
[IOPscience](#)
34. Color-Magnitude Relations of Active and Non-active Galaxies in the Chandra Deep Fields: High-redshift Constraints and Stellar-mass Selection Effects  
Y. Q. Xue *et al.* 2010 *The Astrophysical Journal* **720** 368  
[IOPscience](#)
35. The LABOCA Survey of the Extended Chandra Deep Field South: Two Modes of Star Formation in Active Galactic Nucleus Hosts?  
D. Lutz *et al.* 2010 *The Astrophysical Journal* **712** 1287  
[IOPscience](#)
36. X-ray Constraints on the Active Galactic Nuclei Properties in Spitzer-Infrared Spectrograph Identified  $z \sim 2$  Ultraluminous Infrared Galaxies  
F. E. Bauer *et al.* 2010 *The Astrophysical Journal* **710** 212  
[IOPscience](#)
37. High-Ionization Fe K Emission From Luminous Infrared Galaxies  
K. Iwasawa *et al.* 2009 *The Astrophysical Journal Letters* **695** L103  
[IOPscience](#)
38. Emission and Absorption Properties of Low-Mass Type 2 Active Galaxies with XMM-Newton

Carol E. Thornton *et al.* 2009 *The Astrophysical Journal* **705** 1196

[IOPscience](#)

39. Less Than 10 Percent of Star Formation in  $z \sim 0.6$  Massive Galaxies is Triggered by Major Interactions

Aday R. Robaina *et al.* 2009 *The Astrophysical Journal* **704** 324

[IOPscience](#)

40. The Chandra Deep Protocluster Survey: Ly Blobs are Powered by Heating, Not Cooling

J. E. Geach *et al.* 2009 *The Astrophysical Journal* **700** 1

[IOPscience](#)

41. The VLA Survey of the Chandra Deep Field-South. III. X-Ray Spectral Properties of Radio Sources

P. Tozzi *et al.* 2009 *The Astrophysical Journal* **698** 740

[IOPscience](#)

42. The Star Formation and Nuclear Accretion Histories of Normal Galaxies in the Ages Survey

Casey R. Watson *et al.* 2009 *The Astrophysical Journal* **696** 2206

[IOPscience](#)

43. Ongoing and Co-Evolving Star Formation in zCOSMOS Galaxies Hosting Active Galactic Nuclei

J. D. Silverman *et al.* 2009 *The Astrophysical Journal* **696** 396

[IOPscience](#)

44. The Chandra Deep Protocluster Survey: Evidence for an Enhancement of AGN Activity in the SSA22 Protocluster at  $z = 3.09$

B. D. Lehmer *et al.* 2009 *The Astrophysical Journal* **691** 687

[IOPscience](#)

45. The Chandra Deep Field-South Survey: 2 Ms Source Catalogs

B. Luo *et al.* 2008 *The Astrophysical Journal Supplement Series* **179** 19


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