



Universiteit
Leiden
The Netherlands

Constraining Properties of Dark Matter particles Using Astrophysical Data

Iakubovskiy, D.

Citation

Iakubovskiy, D. (2013, February 13). *Constraining Properties of Dark Matter particles Using Astrophysical Data*. *Casimir PhD Series*. Retrieved from <https://hdl.handle.net/1887/20523>

Version: Not Applicable (or Unknown)

License: [Leiden University Non-exclusive license](#)

Downloaded from: <https://hdl.handle.net/1887/20523>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/20523> holds various files of this Leiden University dissertation.

Author: Iakubovskiy, Dmytro

Title: Constraining properties of dark matter particles using astrophysical data

Issue Date: 2013-02-13

References

- [1] Zwicky, F. Die Rotverschiebung von extragalaktischen Nebeln. *Helvetica Physica Acta* **6**, 110–127 (1933).
- [2] Einasto, J. Dark Matter. *Baltic Astronomy* **20**, 231–240 (2011). 1109.5580.
- [3] Einasto, J. Dark Matter. *ArXiv e-prints* (2009). 0901.0632.
- [4] Roos, M. Astrophysical and Cosmological Probes of Dark Matter. *Journal of Modern Physics* **3**, 1152–1171 (2012). 1208.3662.
- [5] Massey, R., Kitching, T. & Richard, J. The dark matter of gravitational lensing. *Reports on Progress in Physics* **73**, 086901 (2010). 1001.1739.
- [6] Walker, M. G. Dark Matter in the Milky Way’s Dwarf Spheroidal Satellites. *ArXiv e-prints* (2012). 1205.0311.
- [7] Dekel, A. *et al.* Lost and found dark matter in elliptical galaxies. *Nature* **437**, 707–710 (2005). arXiv:astro-ph/0501622.
- [8] Noordermeer, E., van der Hulst, J. M., Sancisi, R., Swaters, R. S. & van Albada, T. S. The mass distribution in early-type disc galaxies: declining rotation curves and correlations with optical properties. *MNRAS* **376**, 1513–1546 (2007). arXiv:astro-ph/0701731.
- [9] Coccato, L. *et al.* Kinematic properties of early-type galaxy haloes using planetary nebulae. *MNRAS* **394**, 1249–1283 (2009). 0811.3203.
- [10] Gilmore, G. *et al.* The Observed Properties of Dark Matter on Small Spatial Scales. *ApJ* **663**, 948–959 (2007). arXiv:astro-ph/0703308.
- [11] Corbelli, E., Lorenzoni, S., Walterbos, R., Braun, R. & Thilker, D. A wide-field H I mosaic of Messier 31. II. The disk warp, rotation, and

- the dark matter halo. *A&A* **511**, A89 (2010). 0912.4133.
- [12] Chemin, L., Carignan, C. & Foster, T. HI kinematics and dynamics of Messier 31. *Astrophys. J.* **705**, 1395–1415 (2009). 0909.3846.
- [13] Sarazin, C. L. X-ray emission from clusters of galaxies. *Reviews of Modern Physics* **58**, 1–115 (1986).
- [14] Einasto, J. & Einasto, M. Dark Matter in Groups and Clusters of Galaxies. In Valtonen, M. J. & Flynn, C. (eds.) *IAU Colloq. 174: Small Galaxy Groups*, vol. 209 of *Astronomical Society of the Pacific Conference Series*, 360 (2000). arXiv:astro-ph/9909437.
- [15] Evrard, A. E., Metzler, C. A. & Navarro, J. F. Mass Estimates of X-Ray Clusters. *ApJ* **469**, 494 (1996). arXiv:astro-ph/9510058.
- [16] Buote, D. A. X-Ray Constraints on Dark Matter in Galaxy Clusters and Elliptical Galaxies: A View from Chandra and XMM. In Ryder, S., Pisano, D., Walker, M. & Freeman, K. (eds.) *Dark Matter in Galaxies*, vol. 220 of *IAU Symposium*, 149 (2004). arXiv:astro-ph/0310579.
- [17] Refregier, A. Weak Gravitational Lensing by Large-Scale Structure. *ARA&A* **41**, 645–668 (2003). arXiv:astro-ph/0307212.
- [18] Bergström, L. Non-baryonic dark matter: observational evidence and detection methods. *Reports on Progress in Physics* **63**, 793–841 (2000). arXiv:hep-ph/0002126.
- [19] Massey, R. *et al.* Dark matter maps reveal cosmic scaffolding. *Nature* **445**, 286–290 (2007). arXiv:astro-ph/0701594.
- [20] Fu, L. *et al.* Very weak lensing in the CFHTLS wide: cosmology from cosmic shear in the linear regime. *A&A* **479**, 9–25 (2008). 0712.0884.
- [21] Komatsu, E. *et al.* Seven-year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Cosmological Interpretation. *ApJS* **192**, 18–+ (2011). 1001.4538.
- [22] Rozo, E. *et al.* Cosmological Constraints from the Sloan Digital Sky Survey maxBCG Cluster Catalog. *ApJ* **708**, 645–660 (2010). 0902.3702.
- [23] Reid, B. A. *et al.* Cosmological constraints from the clustering of the Sloan Digital Sky Survey DR7 luminous red galaxies. *MNRAS* **404**,

- 60–85 (2010). 0907.1659.
- [24] Mantz, A., Allen, S. W., Rapetti, D. & Ebeling, H. The observed growth of massive galaxy clusters - I. Statistical methods and cosmological constraints. *MNRAS* **406**, 1759–1772 (2010). 0909.3098.
- [25] Tinker, J. L. *et al.* Cosmological Constraints from Galaxy Clustering and the Mass-to-number Ratio of Galaxy Clusters. *ApJ* **745**, 16 (2012). 1104.1635.
- [26] Frenk, C. S. & White, S. D. M. Dark matter and cosmic structure. *Annalen der Physik* **524**, 507–534 (2012). 1210.0544.
- [27] Gates, E. I., Gyuk, G. & Turner, M. S. The Local Halo Density. *ApJ* **449**, L123 (1995). arXiv:astro-ph/9505039.
- [28] Lasserre, T. *et al.* Not enough stellar mass Machos in the Galactic halo. *A&A* **355**, L39–L42 (2000). arXiv:astro-ph/0002253.
- [29] Alcock, C. *et al.* Binary Microlensing Events from the MACHO Project. *ApJ* **541**, 270–297 (2000).
- [30] Moniez, M. Microlensing as a probe of the Galactic structure: 20 years of microlensing optical depth studies. *General Relativity and Gravitation* **42**, 2047–2074 (2010). 1001.2707.
- [31] Dar, A. Baryonic Dark Matter and Big Bang Nucleosynthesis. *ApJ* **449**, 550–+ (1995). arXiv:astro-ph/9504082.
- [32] Carr, B. J. Primordial Black Holes: Do They Exist and Are They Useful? *ArXiv Astrophysics e-prints* (2005). arXiv:astro-ph/0511743.
- [33] Capela, F., Pshirkov, M. & Tinyakov, P. Constraints on Primordial Black Holes as Dark Matter Candidates from Star Formation. *ArXiv e-prints* (2012). 1209.6021.
- [34] Wojtak, R., Hansen, S. H. & Hjorth, J. Gravitational redshift of galaxies in clusters as predicted by general relativity. *Nature* **477**, 567–569 (2011). 1109.6571.
- [35] Dodelson, S. The Real Problem with MOND. *International Journal of Modern Physics D* **20**, 2749–2753 (2011). 1112.1320.
- [36] Bekenstein, J. D. & Sanders, R. H. TeVeS/MOND is in harmony with gravitational redshifts in galaxy clusters. *MNRAS* **421**, L59–L61

(2012). 1110.5048.

- [37] Moffat, J. W. & Toth, V. T. Comment on "The Real Problem with MOND" by Scott Dodelson, arXiv:1112.1320. *ArXiv e-prints* (2011). 1112.4386.
- [38] Bertone, G., Hooper, D. & Silk, J. Particle dark matter: evidence, candidates and constraints. *Phys. Rep.* **405**, 279–390 (2005). arXiv: hep-ph/0404175.
- [39] Bertone, G. *Particle Dark Matter : Observations, Models and Searches* (Cambridge University Press, 2010).
- [40] Taoso, M., Bertone, G. & Masiero, A. Dark Matter Candidates: A Ten-Point Test. *JCAP* **0803**, 022 (2008). 0711.4996.
- [41] Drees, M. & Gerbier, G. Mini-Review of Dark Matter: 2012. *ArXiv e-prints* (2012). 1204.2373.
- [42] Fogli, G. L., Lisi, E., Marrone, A. & Palazzo, A. Global analysis of three-flavor neutrino masses and mixings. *Progress in Particle and Nuclear Physics* **57**, 742–795 (2006). arXiv: hep-ph/0506083.
- [43] Lesgourgues, J. & Pastor, S. Massive neutrinos and cosmology. *Phys. Rept.* **429**, 307–379 (2006). astro-ph/0603494.
- [44] Nakamura, K. *et al.* Review of particle physics. *J.Phys.G* **G37**, 075021 (2010).
- [45] Tremaine, S. & Gunn, J. E. Dynamical role of light neutral leptons in cosmology. *Physical Review Letters* **42**, 407–410 (1979).
- [46] Boyarsky, A., Ruchayskiy, O. & Iakubovskiy, D. A lower bound on the mass of dark matter particles. *Journal of Cosmology and Astro-Particle Physics* **3**, 5–+ (2009). 0808.3902.
- [47] Davis, M., Efstathiou, G., Frenk, C. S. & White, S. D. M. The evolution of large-scale structure in a universe dominated by cold dark matter. *ApJ* **292**, 371–394 (1985).
- [48] Madsen, J. Phase-space constraints on bosonic and fermionic dark matter. *Physical Review Letters* **64**, 2744–2746 (1990).
- [49] Madsen, J. Generalized Tremaine-Gunn limits for bosons and fermions. *Phys. Rev. D* **44**, 999–1006 (1991).

- [50] Boyarsky, A. & Ruchayskiy, O. Bounds on Light Dark Matter. *ArXiv e-prints* (2008). 0811.2385.
- [51] Feng, J. L. Dark Matter Candidates from Particle Physics and Methods of Detection. *ARA&A* **48**, 495–545 (2010). 1003.0904.
- [52] Lee, B. W. & Weinberg, S. Cosmological lower bound on heavy-neutrino masses. *Physical Review Letters* **39**, 165–168 (1977).
- [53] Saab, T. An Introduction to Dark Matter Direct Detection Searches and Techniques. *ArXiv e-prints* (2012). 1203.2566.
- [54] Lavalle, J. & Salati, P. Dark matter indirect signatures. *Comptes Rendus Physique* **13**, 740–782 (2012). 1205.1004.
- [55] Bergstrom, L. Saas-Fee Lecture Notes: Multi-messenger Astronomy and Dark Matter. *ArXiv e-prints* (2012). 1202.1170.
- [56] Dodelson, S. & Widrow, L. M. Sterile neutrinos as dark matter. *Physical Review Letters* **72**, 17–20 (1994). arXiv:hep-ph/9303287.
- [57] Asaka, T., Blanchet, S. & Shaposhnikov, M. The numsm, dark matter and neutrino masses. *Phys. Lett.* **B631**, 151–156 (2005). hep-ph/0503065.
- [58] Lattanzi, M. & Valle, J. W. F. Decaying Warm Dark Matter and Neutrino Masses. *Physical Review Letters* **99**, 121301+ (2007). 0705.2406.
- [59] Wilczek, F. Problem of strong P and T invariance in the presence of instantons. *Physical Review Letters* **40**, 279–282 (1978).
- [60] Weinberg, S. A new light boson? *Physical Review Letters* **40**, 223–226 (1978).
- [61] Holman, R., Lazarides, G. & Shafi, Q. Axions and the dark matter of the Universe. *Phys. Rev. D* **27**, 995–997 (1983).
- [62] Pagels, H. & Primack, J. R. Supersymmetry, cosmology, and new physics at teraelectronvolt energies. *Physical Review Letters* **48**, 223–226 (1982).
- [63] Haber, H. E. & Kane, G. L. The search for supersymmetry: Probing physics beyond the standard model. *Phys. Rep.* **117**, 75–263 (1985).

- [64] Covi, L., Kim, J. E. & Roszkowski, L. Axinos as Cold Dark Matter. *Physical Review Letters* **82**, 4180–4183 (1999). arXiv:hep-ph/9905212.
- [65] Takayama, F. & Yamaguchi, M. Gravitino dark matter without R-parity. *Physics Letters B* **485**, 388–392 (2000). arXiv:hep-ph/0005214.
- [66] Covi, L., Kim, H. B., Kim, J. E. & Roszkowski, L. Axinos as dark matter. *Journal of High Energy Physics* **5**, 33 (2001). arXiv:hep-ph/0101009.
- [67] Feng, J. L., Rajaraman, A. & Takayama, F. Superweakly Interacting Massive Particles. *Physical Review Letters* **91**, 011302–+ (2003). arXiv:hep-ph/0302215.
- [68] Feng, J. L., Su, S. & Takayama, F. SuperWIMP gravitino dark matter from slepton and sneutrino decays. *Phys. Rev. D* **70**, 063514–+ (2004). arXiv:hep-ph/0404198.
- [69] Buchmüller, W., Covi, L., Hamaguchi, K., Ibarra, A. & Yanagida, T. T. Gravitino dark matter in R-parity breaking vacua. *Journal of High Energy Physics* **3**, 37–+ (2007). arXiv:hep-ph/0702184.
- [70] Conlon, J. P. & Quevedo, F. Astrophysical and cosmological implications of large volume string compactifications. *Journal of Cosmology and Astro-Particle Physics* **8**, 19–+ (2007). 0705.3460.
- [71] Kusenko, A., Loewenstein, M. & Yanagida, T. T. Moduli dark matter and the search for its decay line using Suzaku X-ray telescope. *ArXiv e-prints* (2012). 1209.6403.
- [72] Bezrukov, F. & Shaposhnikov, M. Searching for dark matter sterile neutrinos in the laboratory. *Phys. Rev. D* **75**, 053005–+ (2007). arXiv:hep-ph/0611352.
- [73] Dolgov, A. D. & Hansen, S. H. Massive sterile neutrinos as warm dark matter. *Astroparticle Physics* **16**, 339–344 (2002). arXiv:hep-ph/0009083.
- [74] Abazajian, K., Fuller, G. M. & Tucker, W. H. Direct Detection of Warm Dark Matter in the X-Ray. *ApJ* **562**, 593–604 (2001). arXiv:astro-ph/0106002.

- [75] den Herder, J. W. *et al.* The search for decaying Dark Matter. *ArXiv e-prints* (2009). 0906.1788.
- [76] Abazajian, K. N. *et al.* Light Sterile Neutrinos: A White Paper. *ArXiv e-prints* (2012). 1204.5379.
- [77] Supper, R. *et al.* ROSAT PSPC survey of M 31. *A&A* **317**, 328–349 (1997).
- [78] Shi, X. & Fuller, G. M. New Dark Matter Candidate: Nonthermal Sterile Neutrinos. *Physical Review Letters* **82**, 2832–2835 (1999). arXiv:astro-ph/9810076.
- [79] Abazajian, K., Fuller, G. M. & Patel, M. Sterile neutrino hot, warm, and cold dark matter. *Phys. Rev. D* **64**, 023501 (2001). arXiv:astro-ph/0101524.
- [80] Asaka, T. & Shaposhnikov, M. The nuMSM, dark matter and baryon asymmetry of the universe. *Phys. Lett. B* **620**, 17–26 (2005). arXiv:hep-ph/0505013.
- [81] Asaka, T., Shaposhnikov, M. & Laine, M. Lightest sterile neutrino abundance within the ν MSM. *Journal of High Energy Physics* **1**, 91–+ (2007). arXiv:hep-ph/0612182.
- [82] Boyarsky, A., Ruchayskiy, O. & Shaposhnikov, M. The Role of Sterile Neutrinos in Cosmology and Astrophysics. *Annual Review of Nuclear and Particle Science* **59**, 191–214 (2009). 0901.0011.
- [83] Kusenko, A. Sterile neutrinos: The dark side of the light fermions. *Phys. Rep.* **481**, 1–28 (2009). 0906.2968.
- [84] Boyarsky, I. D., A. & Ruchayskiy, O. Next decade of sterile neutrino studies (2012). <http://dx.doi.org/10.1016/j.dark.2012.11.001>.
- [85] Cho, A. Physicists’ nightmare scenario: The higgs and nothing else. *Science* **315**, 1657–1658 (2007). URL <http://www.sciencemag.org/content/315/5819/1657.short>. <http://www.sciencemag.org/content/315/5819/1657.full.pdf>.
- [86] Asaka, T., Laine, M. & Shaposhnikov, M. On the hadronic contribution to sterile neutrino production. *Journal of High Energy Physics* **6**, 53 (2006). arXiv:hep-ph/0605209.

- [87] Shaposhnikov, M. The nuMSM, leptonic asymmetries, and properties of singlet fermions. *Journal of High Energy Physics* **8**, 8 (2008). 0804.4542.
- [88] Laine, M. & Shaposhnikov, M. Sterile neutrino dark matter as a consequence of nuMSM-induced lepton asymmetry. *Journal of Cosmology and Astro-Particle Physics* **6**, 31–+ (2008). 0804.4543.
- [89] Minkowski, P. $\mu \rightarrow e \gamma$ at a rate of one out of 1-billion muon decays? *Phys. Lett.* **B67**, 421 (1977).
- [90] Ramond, P. The family group in grand unified theories (1979). hep-ph/9809459.
- [91] Mohapatra, R. N. & Senjanovic, G. Neutrino mass and spontaneous parity nonconservation. *Phys. Rev. Lett.* **44**, 912 (1980).
- [92] Yanagida, T. Horizontal gauge symmetry and masses of neutrinos. *Prog. Theor. Phys.* **64**, 1103 (1980).
- [93] Boyarsky, A., Neronov, A., Ruchayskiy, O. & Shaposhnikov, M. Masses of active neutrinos in the nuMSM from x-ray astronomy. *Soviet Journal of Experimental and Theoretical Physics Letters* **83**, 133–135 (2006). arXiv:hep-ph/0601098.
- [94] Gorbunov, D. & Shaposhnikov, M. How to find neutral leptons of the numsm? *JHEP* **10**, 015 (2007). arXiv:0705.1729[hep-ph].
- [95] Gorbunov, D. & Shaposhnikov, M. Search for GeV-scale sterile neutrinos responsible for active neutrino masses and baryon asymmetry of the universe. Submitted to European Strategy Preparatory Group. Available at <http://indico.cern.ch/contributionDisplay.py?contribId=17&confId=175067>.
- [96] Hewett, J. L. *et al.* Fundamental Physics at the Intensity Frontier. *ArXiv e-prints* (2012). 1205.2671.
- [97] Canetti, L., Drewes, M. & Shaposhnikov, M. Sterile Neutrinos as the Origin of Dark and Baryonic Matter. *ArXiv e-prints* (2012). 1204.3902.
- [98] Pal, P. B. & Wolfenstein, L. Radiative decays of massive neutrinos. *Phys. Rev. D* **25**, 766–773 (1982).

- [99] Boyarsky, A., Lesgourgues, J., Ruchayskiy, O. & Viel, M. Lyman- α constraints on warm and on warm-plus-cold dark matter models. *Journal of Cosmology and Astro-Particle Physics* **5**, 12–+ (2009). 0812.0010.
- [100] Peebles, P. J. E. *The large-scale structure of the universe* (Princeton, N.J., Princeton University Press, 1980. 435 p., 1980).
- [101] Zel'dovich, Y. B. Gravitational instability: An approximate theory for large density perturbations. *A&A* **5**, 84–89 (1970).
- [102] Bisnovatyi-Kogan, G. S. Cosmology with a nonzero neutrino rest mass. *AZh* **57**, 899–902 (1980).
- [103] Bond, J. R., Efstathiou, G. & Silk, J. Massive neutrinos and the large-scale structure of the universe. *Physical Review Letters* **45**, 1980–1984 (1980).
- [104] Doroshkevich, A. G., Khlopov, M. I., Sunyaev, R. A., Szalay, A. S. & Zeldovich, I. B. Cosmological impact of the neutrino rest mass. *New York Academy Sciences Annals* **375**, 32–42 (1981).
- [105] Bode, P., Ostriker, J. P. & Turok, N. Halo Formation in Warm Dark Matter Models. *ApJ* **556**, 93–107 (2001). arXiv:astro-ph/0010389.
- [106] Asaka, T., Shaposhnikov, M. & Kusenko, A. Opening a new window for warm dark matter. *Phys. Lett.* **B638**, 401–406 (2006). hep-ph/0602150.
- [107] Bezrukov, F., Hettmansperger, H. & Lindner, M. keV sterile neutrino dark matter in gauge extensions of the standard model. *Phys. Rev. D* **81**, 085032–+ (2010). 0912.4415.
- [108] Wolfenstein, L. Neutrino oscillations in matter. *Phys. Rev.* **D17**, 2369–2374 (1978).
- [109] Mikheev, S. P. & Smirnov, A. Y. Resonance enhancement of oscillations in matter and solar neutrino spectroscopy. *Sov. J. Nucl. Phys.* **42**, 913–917 (1985).
- [110] Lesgourgues, J. & Pastor, S. Cosmological implications of a relic neutrino asymmetry. *Phys. Rev. D* **60**, 103521–+ (1999). hep-ph/9904411.
- [111] Kirilova, D. On Lepton asymmetry and BBN. *Progress in Particle and*

Nuclear Physics **66**, 260–265 (2011).

- [112] Serpico, P. D. & Raffelt, G. G. Lepton asymmetry and primordial nucleosynthesis in the era of precision cosmology. *Phys. Rev.* **D71**, 127301 (2005). astro-ph/0506162.
- [113] Mangano, G., Miele, G., Pastor, S., Pisanti, O. & Sarikas, S. Constraining the cosmic radiation density due to lepton number with Big Bang Nucleosynthesis. *JCAP* **1103**, 035 (2011). 1011.0916.
- [114] Castorina, E. *et al.* Cosmological lepton asymmetry with a nonzero mixing angle θ_{13} . *Phys.Rev.* **D86**, 023517 (2012). 1204.2510.
- [115] Benson, A. J. *et al.* Dark Matter Halo Merger Histories Beyond Cold Dark Matter: I - Methods and Application to Warm Dark Matter (2012). 1209.3018.
- [116] Sommer-Larsen, J., Naselsky, P., Novikov, I. & Gotz, M. Inhomogeneous Primordial Baryon Distributions on Sub-Galactic Scales: High- z Galaxy Formation with WDM. *Mon. Not. Roy. Astron. Soc.* **352**, 299 (2004). astro-ph/0309329.
- [117] O’Shea, B. W. & Norman, M. L. Population III star formation in a Lambda WDM universe. *Astrophys. J.* **648**, 31–46 (2006). astro-ph/0602319.
- [118] Gao, L. & Theuns, T. Lighting the Universe with filaments. *Science* **317**, 1527 (2007). 0709.2165.
- [119] Hansen, S. H. & Haiman, Z. Do we need stars to reionize the universe at high redshifts? Early reionization by decaying heavy sterile neutrinos. *Astrophys.J.* **600**, 26–31 (2004). astro-ph/0305126.
- [120] Yoshida, N., Sokasian, A., Hernquist, L. & Springel, V. Early Structure Formation and Reionization in a Warm Dark Matter Cosmology. *Astrophys. J.* **591**, L1–L4 (2003). astro-ph/0303622.
- [121] Yue, B. & Chen, X. Reionization in the Warm Dark Matter Model. *Astrophys.J.* **747**, 127 (2012). 1201.3686.
- [122] Hansen, S. H., Lesgourgues, J., Pastor, S. & Silk, J. Closing the window on warm dark matter. *MNRAS* **333**, 544–546 (2002). astro-ph/0106108.

- [123] Viel, M., Lesgourgues, J., Haehnelt, M. G., Matarrese, S. & Riotto, A. Constraining warm dark matter candidates including sterile neutrinos and light gravitinos with wmap and the Lyman- alpha forest. *Phys. Rev.* **D71**, 063534 (2005). astro-ph/0501562.
- [124] Viel, M., Lesgourgues, J., Haehnelt, M. G., Matarrese, S. & Riotto, A. Can sterile neutrinos be ruled out as warm dark matter candidates? *Phys. Rev. Lett.* **97**, 071301 (2006). astro-ph/0605706.
- [125] Seljak, U., Makarov, A., McDonald, P. & Trac, H. Can sterile neutrinos be the dark matter? *Phys. Rev. Lett.* **97**, 191303 (2006). astro-ph/0602430.
- [126] Viel, M. *et al.* How cold is cold dark matter? Small scales constraints from the flux power spectrum of the high-redshift Lyman-alpha forest. *Phys. Rev. Lett.* **100**, 041304 (2008). 0709.0131.
- [127] Strigari, L. E. *et al.* A large dark matter core in the fornax dwarf spheroidal galaxy? *ApJ* **652**, 306–312 (2006). arXiv:astro-ph/0603775.
- [128] Colin, P., Valenzuela, O. & Avila-Reese, V. On the Structure of Dark Matter Halos at the Damping Scale of the Power Spectrum with and without Relict Velocities. *Astrophys. J.* **673**, 203–214 (2008). 0709.4027.
- [129] de Naray, R. K., Martinez, G. D., Bullock, J. S. & Kaplinghat, M. The Case Against Warm or Self-Interacting Dark Matter as Explanations for Cores in Low Surface Brightness Galaxies (2009). 0912.3518.
- [130] Schneider, A., Smith, R. E., Maccio, A. V. & Moore, B. Nonlinear Evolution of Cosmological Structures in Warm Dark Matter Models (2011). 1112.0330.
- [131] Boyarsky, A., Lesgourgues, J., Ruchayskiy, O. & Viel, M. Realistic Sterile Neutrino Dark Matter with KeV Mass does not Contradict Cosmological Bounds. *Physical Review Letters* **102**, 201304–+ (2009). 0812.3256.
- [132] Jedamzik, K., Lemoine, M. & Moutaka, G. Gravitino, axino, Kaluza-Klein graviton warm and mixed dark matter and reionisation. *JCAP* **0607**, 010 (2006). astro-ph/0508141.

- [133] Lovell, M. *et al.* The Haloes of Bright Satellite Galaxies in a Warm Dark Matter Universe. *MNRAS* *to appear* (2011). 1104.2929.
- [134] Klypin, A., Kravtsov, A. V., Valenzuela, O. & Prada, F. Where Are the Missing Galactic Satellites? *ApJ* **522**, 82–92 (1999). arXiv:astro-ph/9901240.
- [135] Moore, B. *et al.* Dark matter substructure within galactic halos. *Astrophys. J.* **524**, L19–L22 (1999). arXiv:astro-ph/9907411.
- [136] Bullock, J. S., Kravtsov, A. V. & Weinberg, D. H. Reionization and the Abundance of Galactic Satellites. *ApJ* **539**, 517–521 (2000). arXiv:astro-ph/0002214.
- [137] Benson, A. J., Frenk, C. S., Lacey, C. G., Baugh, C. M. & Cole, S. The effects of photoionization on galaxy formation - II. Satellite galaxies in the Local Group. *MNRAS* **333**, 177–190 (2002). arXiv:astro-ph/0108218.
- [138] Somerville, R. S. Can Photoionization Squelching Resolve the Substructure Crisis? *ApJ* **572**, L23–L26 (2002). arXiv:astro-ph/0107507.
- [139] Macciò, A. V. *et al.* Luminosity function and radial distribution of Milky Way satellites in a Λ CDM Universe. *MNRAS* **402**, 1995–2008 (2010). 0903.4681.
- [140] Strigari, L. E., Frenk, C. S. & White, S. D. M. Kinematics of Milky Way satellites in a Lambda cold dark matter universe. *MNRAS* **408**, 2364–2372 (2010). 1003.4268.
- [141] Boylan-Kolchin, M., Bullock, J. S. & Kaplinghat, M. Too big to fail? The puzzling darkness of massive Milky Way subhalos. *MNRAS* **415**, L40–L44 (2011). 1103.0007.
- [142] Stasielak, J., Biermann, P. L. & Kusenko, A. Thermal evolution of the primordial clouds in warm dark matter models with keV sterile neutrinos. *ApJ* **654**, 290–303 (2007). arXiv:astro-ph/0606435.
- [143] Ripamonti, E., Mapelli, M. & Ferrara, A. The impact of dark matter decays and annihilations on the formation of the first structures. *Mon. Not. Roy. Astron. Soc.* **375**, 1399–1408 (2007). astro-ph/0606483.
- [144] Biermann, P. L. & Kusenko, A. Relic keV sterile neutrinos and reion-

- ization. *Phys. Rev. Lett.* **96**, 091301 (2006). astro-ph/0601004.
- [145] Kusenko, A. Sterile dark matter and reionization (2006). astro-ph/0609375.
- [146] Mapelli, M., Ferrara, A. & Pierpaoli, E. Impact of dark matter decays and annihilations on reionization. *Mon. Not. Roy. Astron. Soc.* **369**, 1719–1724 (2006). astro-ph/0603237.
- [147] Ripamonti, E., Mapelli, M. & Ferrara, A. Intergalactic medium heating by dark matter. *Mon. Not. Roy. Astron. Soc.* **374**, 1067–1077 (2007). astro-ph/0606482.
- [148] Viel, M., Schaye, J. & Booth, C. M. The impact of feedback from galaxy formation on the Lyman-alpha transmitted flux (2012). 1207.6567.
- [149] Viel, M., Markovic, K., Baldi, M. & Weller, J. The Non-Linear Matter Power Spectrum in Warm Dark Matter Cosmologies. *MNRAS* (2011). 1107.4094.
- [150] Smith, R. E. & Markovic, K. Testing the Warm Dark Matter paradigm with large-scale structures. *Phys. Rev.* **D84**, 063507 (2011). 1103.2134.
- [151] Markovic, K., Bridle, S., Slosar, A. & Weller, J. Constraining warm dark matter with cosmic shear power spectra. *JCAP* **1101**, 022 (2011). 1009.0218.
- [152] Miranda, M. & Macciò, A. V. Constraining Warm Dark Matter using QSO gravitational lensing **706** (2007). 0706.0896.
- [153] Dunstan, R. M., Abazajian, K. N., Polisensky, E. & Ricotti, M. The Halo Model of Large Scale Structure for Warm Dark Matter (2011). 1109.6291.
- [154] Polisensky, E. & Ricotti, M. Constraints on the Dark Matter Particle Mass from the Number of Milky Way Satellites. *Phys. Rev.* **D83**, 043506 (2011). 1004.1459.
- [155] Macciò, A. V. & Fontanot, F. How cold is dark matter? Constraints from Milky Way satellites. *MNRAS* **404**, L16–L20 (2010). 0910.2460.
- [156] Macciò, A. V., Paduroiu, S., Anderhalden, D., Schneider, A. & Moore, B. Cores in warm dark matter haloes: a Catch 22 problem. *MNRAS*

424, 1105–1112 (2012). 1202.1282.

- [157] Shao, S., Gao, L., Theuns, T. & Frenk, C. S. The phase space density of fermionic dark matter haloes (2012). 1209.5563.
- [158] Vernet, J. *et al.* X-shooter, the new wide band intermediate resolution spectrograph at the ESO Very Large Telescope. *A&A* **536**, A105 (2011). 1110.1944.
- [159] Semboloni, E., Hoekstra, H., Schaye, J., van Daalen, M. P. & McCarthy, I. J. Quantifying the effect of baryon physics on weak lensing tomography. *MNRAS* **417**, 2020–2035 (2011). 1105.1075.
- [160] van Daalen, M. P., Schaye, J., Booth, C. M. & Vecchia, C. D. The effects of galaxy formation on the matter power spectrum: A challenge for precision cosmology. *Mon. Not. Roy. Astron. Soc.* **415**, 3649–3665 (2011). 1104.1174.
- [161] Maccio', A. V., Ruchayskiy, O., Boyarsky, A. & Munoz-Cuartas, J. C. The inner structure of haloes in Cold+Warm dark matter models. *MNRAS* (2012). 1202.2858.
- [162] Mandelbaum, R., Seljak, U. & Hirata, C. M. Halo mass - concentration relation from weak lensing. *JCAP* **0808**, 006 (2008). 0805.2552.
- [163] King, L. J. & Mead, J. M. G. The mass-concentration relationship of virialized haloes and its impact on cosmological observables. *MNRAS* **416**, 2539–2549 (2011). 1105.3155.
- [164] Bilic, N. & Viollier, R. D. Gravitational phase transition of fermionic matter. *Phys. Lett. B* **408**, 75–80 (1997). arXiv:astro-ph/9607077.
- [165] Viollier, R. D. Neutrino halos around baryonic stars and supermassive neutrino stars - Atoms of the macrocosm? *Progress in Particle and Nuclear Physics* **32**, 51–74 (1994).
- [166] Martin, N. F., de Jong, J. T. A. & Rix, H.-W. A Comprehensive Maximum Likelihood Analysis of the Structural Properties of Faint Milky Way Satellites. *ApJ* **684**, 1075–1092 (2008). 0805.2945.
- [167] Kuhlen, M., Diemand, J. & Madau, P. The Shapes, Orientation, and Alignment of Galactic Dark Matter Subhalos. *ApJ* **671**, 1135–1146 (2007). 0705.2037.

- [168] Tremaine, S., Hénon, M. & Lynden-Bell, D. H-functions and mixing in violent relaxation. *MNRAS* **219**, 285–297 (1986).
- [169] Cowsik, R. & Ghosh, P. Dark matter in the universe - Massive neutrinos revisited. *ApJ* **317**, 26–51 (1987).
- [170] Madsen, J. & Epstein, R. I. Firm bounds on the neutrino mass from the distribution of dark matter in galaxies. *ApJ* **282**, 11–18 (1984).
- [171] Madsen, J. Dark matter phase space densities. *Phys. Rev. D* **64**, 027301–+ (2001). [arXiv:astro-ph/0006074](#).
- [172] Boyanovsky, D., de Vega, H. J. & Sanchez, N. G. Constraints on dark matter particles from theory, galaxy observations, and N-body simulations. *Phys. Rev. D* **77**, 043518–+ (2008). [arXiv:0710.5180](#).
- [173] Gorbunov, D., Khmel'nitsky, A. & Rubakov, V. Constraining sterile neutrino dark matter by phase-space density observations. *JCAP* **0810**, 041 (2008). [0808.3910](#).
- [174] Binney, J. & Tremaine, S. *Galactic Dynamics: Second Edition* (Galactic Dynamics: Second Edition, by James Binney and Scott Tremaine. ISBN 978-0-691-13026-2 (HB). Published by Princeton University Press, Princeton, NJ USA, 2008., 2008).
- [175] Hogan, C. J. & Dalcanton, J. J. New dark matter physics: Clues from halo structure. *Phys. Rev. D* **62**, 063511–+ (2000). [arXiv:astro-ph/0002330](#).
- [176] Dalcanton, J. J. & Hogan, C. J. Halo cores and phase space densities: Observational constraints on dark matter physics and structure formation. *ApJ* **561**, 35–45 (2001). [astro-ph/0004381](#).
- [177] Hansen, S. H., Egli, D., Hollenstein, L. & Salzmann, C. Dark matter distribution function from non-extensive statistical mechanics. *New Astronomy* **10**, 379–384 (2005). [arXiv:astro-ph/0407111](#).
- [178] Bolz, M., Brandenburg, A. & Buchmüller, W. Thermal production of gravitinos. *Nucl.Phys. B* **606**, 518–544 (2001). [hep-ph/0012052](#).
- [179] Rychkov, V. S. & Strumia, A. Thermal production of gravitinos. *Phys. Rev. D* **75**, 075011 (2007). [hep-ph/0701104](#).
- [180] Borgani, S., Masiero, A. & Yamaguchi, M. Light gravitinos as mixed

- dark matter. *Phys. Lett.* **B386**, 189–197 (1996). hep-ph/9605222.
- [181] Antonov, V. A. *Solution of the problem of stability of stellar system Emden's density law and the spherical distribution of velocities* (Vestnik Leningradskogo Universiteta, Leningrad: University, 1962, 1962).
- [182] Lynden-Bell, D. & Wood, R. The gravo-thermal catastrophe in isothermal spheres and the onset of red-giant structure for stellar systems. *MNRAS* **138**, 495–+ (1968).
- [183] Pryor, C. & Kormendy, J. The dark matter halos of Draco and Ursa Minor. *AJ* **100**, 127–140 (1990).
- [184] Cole, S. & Lacey, C. The structure of dark matter haloes in hierarchical clustering models. *MNRAS* **281**, 716 (1996). arXiv:astro-ph/9510147.
- [185] Carlberg, R. G. *et al.* The Average Mass Profile of Galaxy Clusters. *ApJ* **485**, L13+ (1997). arXiv:astro-ph/9703107.
- [186] Hansen, S. H. & Moore, B. A universal density slope Velocity anisotropy relation for relaxed structures. *New Astronomy* **11**, 333–338 (2006).
- [187] Zait, A., Hoffman, Y. & Shlosman, I. Dark Matter Halos: Velocity Anisotropy-Density Slope Relation. *ApJ* **682**, 835–840 (2008). 0711.3791.
- [188] Van Hese, E., Baes, M. & Dejonghe, H. The Dynamical Structure of Dark Matter Halos with Universal Properties. *ApJ* **690**, 1280–1291 (2009). 0809.0901.
- [189] An, J. H. & Evans, N. W. A Cusp Slope-Central Anisotropy Theorem. *ApJ* **642**, 752–758 (2006). arXiv:astro-ph/0511686.
- [190] Evans, N. W., An, J. & Walker, M. G. Cores and cusps in the dwarf spheroidals. *MNRAS* **393**, L50–L54 (2009). 0811.1488.
- [191] Strigari, L. E. *et al.* The Most Dark-Matter-dominated Galaxies: Predicted Gamma-Ray Signals from the Faintest Milky Way Dwarfs. *ApJ* **678**, 614–620 (2008). arXiv:0709.1510.
- [192] Strigari, L. E. *et al.* Redefining the Missing Satellites Problem. *ApJ* **669**, 676–683 (2008). 0704.1817.

- [193] Wu, X. The mass distribution of dwarf spheroidal galaxies from stellar kinematics: Draco, Ursa Minor and Fornax (2007). [astro-ph/0702233](#).
- [194] Klypin, A., Zhao, H. & Somerville, R. S. Λ CDM-based Models for the Milky Way and M31. I. Dynamical Models. *ApJ* **573**, 597–613 (2002). [astro-ph/0110390](#).
- [195] Battaglia, G. *et al.* The radial velocity dispersion profile of the Galactic halo: constraining the density profile of the dark halo of the Milky Way. *MNRAS* **364**, 433–442 (2005). [arXiv:astro-ph/0506102](#).
- [196] Walker, M. G. *et al.* A Universal Mass Profile for Dwarf Spheroidal Galaxies? *ApJ* **704**, 1274–1287 (2009). [0906.0341](#).
- [197] Widrow, L. M. & Dubinski, J. Equilibrium Disk-Bulge-Halo Models for the Milky Way and Andromeda Galaxies. *ApJ* **631**, 838–855 (2005). [arXiv:astro-ph/0506177](#).
- [198] Gastaldello, F. *et al.* Probing the Dark Matter and Gas Fraction in Relaxed Galaxy Groups with X-Ray Observations from Chandra and XMM-Newton. *ApJ* **669**, 158–183 (2007). [arXiv:astro-ph/0610134](#).
- [199] Mateo, M., Hurley-Keller, D. & Nemeč, J. Dwarf Cepheids in the Carina Dwarf Spheroidal Galaxy. *AJ* **115**, 1856–1868 (1998). [arXiv:astro-ph/9807233](#).
- [200] Belokurov, V. *et al.* Cats and Dogs, Hair and a Hero: A Quintet of New Milky Way Companions. *ApJ* **654**, 897–906 (2007). [arXiv:astro-ph/0608448](#).
- [201] Koposov, S. *et al.* The Luminosity Function of the Milky Way Satellites. *ApJ* **663**, 948 (2007). [0706.2687](#).
- [202] Irwin, M. J. *et al.* Discovery of an Unusual Dwarf Galaxy in the Outskirts of the Milky Way. *ApJ* **656**, L13–L16 (2007). [arXiv:astro-ph/0701154](#).
- [203] Zucker, D. B. *et al.* A Curious Milky Way Satellite in Ursa Major. *ApJ* **650**, L41–L44 (2006). [arXiv:astro-ph/0606633](#).
- [204] Belokurov, V. *et al.* A Faint New Milky Way Satellite in Bootes. *ApJ* **647**, L111–L114 (2006). [arXiv:astro-ph/0604355](#).

- [205] Gilmore, G. Dark Matter on small scales; Telescopes on large scales. *ArXiv Astrophysics e-prints* (2007). arXiv:astro-ph/0703370.
- [206] Simon, J. D. & Geha, M. The Kinematics of the Ultra-Faint Milky Way Satellites: Solving the Missing Satellite Problem. *ApJ* **670**, 313–331 (2007). arXiv:0706.0516.
- [207] Mateo, M., Olszewski, E., Welch, D. L., Fischer, P. & Kunkel, W. A kinematic study of the Fornax dwarf spheroidal galaxy. *AJ* **102**, 914–926 (1991).
- [208] Bonanos, A. Z., Stanek, K. Z., Szentgyorgyi, A. H., Sasselov, D. D. & Bakos, G. Á. The RR Lyrae Distance to the Draco Dwarf Spheroidal Galaxy. *AJ* **127**, 861–867 (2004). arXiv:astro-ph/0310477.
- [209] Dall’Ora, M. *et al.* Variable Stars in the Newly Discovered Milky Way Satellite in Bootes. *ApJ* **653**, L109–L112 (2006). arXiv:astro-ph/0611285.
- [210] Coleman, M. G. *et al.* The Elongated Structure of the Hercules Dwarf Spheroidal Galaxy from Deep Large Binocular Telescope Imaging. *ApJ* **668**, L43–L46 (2007).
- [211] de Jong, J. T. A. *et al.* The Structural Properties and Star Formation History of Leo T from Deep LBT Photometry. *ApJ* **680**, 1112–1119 (2008). arXiv:0801.4027.
- [212] Okamoto, S., Arimoto, N., Yamada, Y. & Onodera, M. A Suprime-Cam study of the stellar population of the Ursa Major I dwarf spheroidal galaxy. *A&A* **487**, 103–108 (2008). 0804.2976.
- [213] Lee, M. G. *et al.* Deep Wide-Field BVI CCD Photometry of the Sextans Dwarf Spheroidal Galaxy. *AJ* **126**, 2840–2866 (2003).
- [214] Rizzi, L., Held, E. V., Saviane, I., Tully, R. B. & Gullieuszik, M. The distance to the Fornax dwarf spheroidal galaxy. *MNRAS* **380**, 1255–1260 (2007). arXiv:0707.0521.
- [215] Bellazzini, M., Gennari, N., Ferraro, F. R. & Sollima, A. The distance to the Leo I dwarf spheroidal galaxy from the red giant branch tip. *MNRAS* **354**, 708–712 (2004). arXiv:astro-ph/0407444.
- [216] Bellazzini, M., Gennari, N. & Ferraro, F. R. The red giant branch tip and bump of the Leo II dwarf spheroidal galaxy. *MNRAS* **360**, 185–

- 193 (2005). arXiv:astro-ph/0503418.
- [217] Pietrzyński, G. *et al.* The Araucaria Project: the Distance to the Sculptor Dwarf Spheroidal Galaxy from Infrared Photometry of RR Lyrae Stars. *AJ* **135**, 1993–1997 (2008). arXiv:0804.0347.
- [218] Landau, L. D. & Lifshitz, E. M. *The classical theory of fields* (Course of theoretical physics - Pergamon International Library of Science, Technology, Engineering and Social Studies, Oxford: Pergamon Press, 1975, 4th rev.engl.ed., 1975).
- [219] Muñoz, R. R. *et al.* Exploring Halo Substructure with Giant Stars: The Dynamics and Metallicity of the Dwarf Spheroidal in Boötes. *ApJ* **650**, L51–L54 (2006). arXiv:astro-ph/0606271.
- [220] Spergel, D. N. *et al.* Three-Year Wilkinson Microwave Anisotropy Probe (WMAP) Observations: Implications for Cosmology. *ApJS* **170**, 377–408 (2007). arXiv:astro-ph/0603449.
- [221] Boyarsky, A., Neronov, A., Ruchayskiy, O. & Shaposhnikov, M. Constraints on sterile neutrinos as dark matter candidates from the diffuse X-ray background. *MNRAS* **370**, 213–218 (2006). arXiv:astro-ph/0512509.
- [222] Boyarsky, A., Neronov, A., Ruchayskiy, O. & Shaposhnikov, M. Restrictions on parameters of sterile neutrino dark matter from observations of galaxy clusters. *Phys. Rev. D* **74**, 103506 (2006). arXiv:astro-ph/0603368.
- [223] Boyarsky, A., Neronov, A., Ruchayskiy, O., Shaposhnikov, M. & Tkachev, I. Strategy for Searching for a Dark Matter Sterile Neutrino. *Physical Review Letters* **97**, 261302–+ (2006). arXiv:astro-ph/0603660.
- [224] Riemer-Sørensen, S., Hansen, S. H. & Pedersen, K. Sterile Neutrinos in the Milky Way: Observational Constraints. *ApJ* **644**, L33–L36 (2006). arXiv:astro-ph/0603661.
- [225] Watson, C. R., Beacom, J. F., Yüksel, H. & Walker, T. P. Direct x-ray constraints on sterile neutrino warm dark matter. *Phys. Rev. D* **74**, 033009–+ (2006). arXiv:astro-ph/0605424.
- [226] Boyarsky, A., Ruchayskiy, O. & Markevitch, M. Constraints on Para-

- meters of Radiatively Decaying Dark Matter from the Galaxy Cluster 1E 0657-56. *ApJ* **673**, 752–757 (2008). arXiv:astro-ph/0611168.
- [227] Abazajian, K. N., Markevitch, M., Koushiappas, S. M. & Hickox, R. C. Limits on the Radiative Decay of Sterile Neutrino Dark Matter from the Unresolved Cosmic and Soft X-ray Backgrounds. *Phys. Rev. D* **75**, 063511–+ (2007). arXiv:astro-ph/0611144.
- [228] Boyarsky, A., Nevalainen, J. & Ruchayskiy, O. Constraints on the parameters of radiatively decaying dark matter from the dark matter halos of the Milky Way and Ursa Minor. *A&A* **471**, 51–57 (2007). arXiv:astro-ph/0610961.
- [229] Boyarsky, A., den Herder, J., Neronov, A. & Ruchayskiy, O. Search for the light dark matter with an X-ray spectrometer. *Astroparticle Physics* **28**, 303–311 (2007). arXiv:astro-ph/0612219.
- [230] Boyarsky, A., Iakubovskiy, D., Ruchayskiy, O. & Savchenko, V. Constraints on decaying dark matter from XMM-Newton observations of M31. *MNRAS* **387**, 1361–1373 (2008). arXiv:0709.2301.
- [231] Boyarsky, A., Malyshev, D., Neronov, A. & Ruchayskiy, O. Constraining DM properties with SPI. *MNRAS* **387**, 1345–1360 (2008). 0710.4922.
- [232] Shaposhnikov, M. & Tkachev, I. The numsm, inflation, and dark matter. *Phys. Lett.* **B639**, 414–417 (2006). hep-ph/0604236.
- [233] Kusenko, A. Sterile neutrinos, dark matter, and the pulsar velocities in models with a higgs singlet. *Phys. Rev. Lett.* **97**, 241301 (2006). hep-ph/0609081.
- [234] Petraki, K. & Kusenko, A. Dark-matter sterile neutrinos in models with a gauge singlet in the Higgs sector. *Phys. Rev.* **D77**, 065014 (2008). 0711.4646.
- [235] Petraki, K. Small-scale structure formation properties of chilled sterile neutrinos as dark matter. *Phys. Rev. D* **77**, 105004–+ (2008). arXiv:0801.3470.
- [236] Gorbunov, D., Khmel'nitsky, A. & Rubakov, V. Is gravitino still a warm dark matter candidate? (2008). 0805.2836.
- [237] Boyanovsky, D. Clustering properties of a sterile neutrino dark matter

- candidate. *Phys. Rev.* **D78**, 103505 (2008). 0807.0646.
- [238] Blumenthal, G. R., Faber, S. M., Flores, R. & Primack, J. R. Contraction of dark matter galactic halos due to baryonic infall. *ApJ* **301**, 27–34 (1986).
- [239] Gnedin, O. Y., Kravtsov, A. V., Klypin, A. A. & Nagai, D. Response of Dark Matter Halos to Condensation of Baryons: Cosmological Simulations and Improved Adiabatic Contraction Model. *ApJ* **616**, 16–26 (2004). arXiv:astro-ph/0406247.
- [240] Lin, D. N. C. & Faber, S. M. Some implications of nonluminous matter in dwarf spheroidal galaxies. *ApJ* **266**, L21–L25 (1983).
- [241] Moore, B. Evidence against Dissipationless Dark Matter from Observations of Galaxy Haloes. *Nature* **370**, 629–+ (1994).
- [242] Mastropietro, C. *et al.* Morphological evolution of discs in clusters. *MNRAS* **364**, 607–619 (2005). arXiv:astro-ph/0411648.
- [243] Mayer, L., Mastropietro, C., Wadsley, J., Stadel, J. & Moore, B. Simultaneous ram pressure and tidal stripping; how dwarf spheroidals lost their gas. *MNRAS* **369**, 1021–1038 (2006). arXiv:astro-ph/0504277.
- [244] Mayer, L., Kazantzidis, S., Mastropietro, C. & Wadsley, J. Early gas stripping as the origin of the darkest galaxies in the Universe. *Nature* **445**, 738–740 (2007). arXiv:astro-ph/0702495.
- [245] Read, A. M., Sembay, S. F., Abbey, T. F. & Turner, M. J. L. ‘Patching’ EPIC-MOS: Temporal and Spatial Dependency of the Detector Response. In A. Wilson (ed.) *The X-ray Universe 2005*, vol. 604 of *ESA Special Publication*, 925 (2006).
- [246] Naab, T., Johansson, P. H., Ostriker, J. P. & Efstathiou, G. Formation of Early-Type Galaxies from Cosmological Initial Conditions. *ApJ* **658**, 710–720 (2007). arXiv:astro-ph/0512235.
- [247] Kormendy, J. & Freeman, K. C. Scaling Laws for Dark Matter Halos in Late-Type and Dwarf Spheroidal Galaxies. In Ryder, S., Pisano, D., Walker, M. & Freeman, K. (eds.) *Dark Matter in Galaxies*, vol. 220 of *IAU Symposium*, 377 (2004). arXiv:astro-ph/0407321.
- [248] Donato, F. *et al.* A constant dark matter halo surface density in galax-

- ies. *MNRAS* **397**, 1169–1176 (2009). 0904.4054.
- [249] Gentile, G., Famaey, B., Zhao, H. & Salucci, P. Universality of galactic surface densities within one dark halo scale-length. *Nature* **461**, 627–628 (2009). 0909.5203.
- [250] Bardeau, S. *et al.* A CFH12k lensing survey of X-ray luminous galaxy clusters. II. Weak lensing analysis and global correlations. *A&A* **470**, 449–466 (2007). arXiv:astro-ph/0703395.
- [251] Broadhurst, T., Umetsu, K., Medezinski, E., Oguri, M. & Rephaeli, Y. Comparison of Cluster Lensing Profiles with Λ CDM Predictions. *ApJ* **685**, L9–L12 (2008). 0805.2617.
- [252] Comerford, J. M. & Natarajan, P. The observed concentration-mass relation for galaxy clusters. *MNRAS* **379**, 190–200 (2007). arXiv:astro-ph/0703126.
- [253] Corless, V. L., King, L. J. & Clowe, D. A new look at massive clusters: weak lensing constraints on the triaxial dark matter haloes of A1689, A1835 and A2204. *MNRAS* **393**, 1235–1254 (2009). 0812.0632.
- [254] Donnarumma, A., Ettori, S., Meneghetti, M. & Moscardini, L. X-ray and strong lensing mass estimate of MS2137.3-2353. *MNRAS* **398**, 438–450 (2009). 0902.4051.
- [255] Ettori, S., De Grandi, S. & Molendi, S. Gravitating mass profiles of nearby galaxy clusters and relations with X-ray gas temperature, luminosity and mass. *A&A* **391**, 841–855 (2002). arXiv:astro-ph/0206120.
- [256] Gavazzi, R. *et al.* A weak lensing study of the Coma cluster. *A&A* **498**, L33–L36 (2009). 0904.0220.
- [257] Kubo, J. M. *et al.* The Mass of the Coma Cluster from Weak Lensing in the Sloan Digital Sky Survey. *ApJ* **671**, 1466–1470 (2007). 0709.0506.
- [258] McLaughlin, D. E. Evidence in Virgo for the Universal Dark Matter Halo. *ApJ* **512**, L9–L12 (1999). arXiv:astro-ph/9812242.
- [259] Rines, K., Geller, M. J., Kurtz, M. J. & Diaferio, A. CAIRNS: The Cluster and Infall Region Nearby Survey. I. Redshifts and Mass Profiles. *AJ* **126**, 2152–2170 (2003). arXiv:astro-ph/0306538.

- [260] Schmidt, R. W. & Allen, S. W. The dark matter haloes of massive, relaxed galaxy clusters observed with Chandra. *MNRAS* **379**, 209–221 (2007). [arXiv:astro-ph/0610038](https://arxiv.org/abs/astro-ph/0610038).
- [261] Sereno, M., Lubini, M. & Jetzer, P. A multiwavelength strong lensing analysis of baryons and dark matter in the dynamically active cluster AC 114. *A&A* **518**, A55 (2010). [0904.0018](https://arxiv.org/abs/0904.0018).
- [262] Umetsu, K. & Broadhurst, T. Combining Lens Distortion and Depletion to Map the Mass Distribution of A1689. *ApJ* **684**, 177–203 (2008). [0712.3441](https://arxiv.org/abs/0712.3441).
- [263] <http://sites.google.com/site/dima806/clusters.pdf>.
- [264] Romanowsky, A. J. *et al.* Mapping The Dark Side with DEIMOS: Globular Clusters, X-Ray Gas, and Dark Matter in the NGC 1407 Group. *AJ* **137**, 4956–4987 (2009). [0809.2088](https://arxiv.org/abs/0809.2088).
- [265] Sun, M. *et al.* Chandra Studies of the X-Ray Gas Properties of Galaxy Groups. *ApJ* **693**, 1142–1172 (2009). [0805.2320](https://arxiv.org/abs/0805.2320).
- [266] <http://sites.google.com/site/dima806/groups.pdf>.
- [267] Humphrey, P. J. *et al.* A Chandra View of Dark Matter in Early-Type Galaxies. *ApJ* **646**, 899–918 (2006). [arXiv:astro-ph/0601301](https://arxiv.org/abs/astro-ph/0601301).
- [268] Weijmans, A.-M. *et al.* The shape of the dark matter halo in the early-type galaxy NGC 2974. *MNRAS* **383**, 1343–1358 (2008). [0711.1775](https://arxiv.org/abs/0711.1775).
- [269] Weijmans, A. *et al.* Stellar velocity profiles and line strengths out to four effective radii in the early-type galaxies NGC3379 and 821. *MNRAS* **398**, 561–574 (2009). [0906.0018](https://arxiv.org/abs/0906.0018).
- [270] Napolitano, N. R. *et al.* The Planetary Nebula Spectrograph elliptical galaxy survey: the dark matter in NGC 4494. *MNRAS* **393**, 329–353 (2009). [0810.1291](https://arxiv.org/abs/0810.1291).
- [271] Zhang, Z. *et al.* Probing the Mass Distributions in NGC 1407 and Its Associated Group with the X-Ray Imaging Spectroscopic and Optical Photometric and Line-Strength Indices Data. *ApJ* **656**, 805–817 (2007). [arXiv:astro-ph/0610934](https://arxiv.org/abs/astro-ph/0610934).
- [272] <http://sites.google.com/site/dima806/ellipticals.pdf>.
- [273] Athanassoula, E., Bosma, A. & Papaioannou, S. Halo parameters of

- spiral galaxies. *A&A* **179**, 23–40 (1987).
- [274] Begeman, K. G., Broeils, A. H. & Sanders, R. H. Extended rotation curves of spiral galaxies - Dark haloes and modified dynamics. *MNRAS* **249**, 523–537 (1991).
- [275] Begum, A. & Chengalur, J. N. Kinematics of two dwarf galaxies in the NGC 6946 group. *A&A* **424**, 509–517 (2004).
- [276] Blais-Ouellette, S., Carignan, C., Amram, P. & Côté, S. Accurate Parameters of the Mass Distribution in Spiral Galaxies. I. Fabry-Perot Observations of NGC 5585. *AJ* **118**, 2123–2131 (1999). [arXiv:astro-ph/9911223](https://arxiv.org/abs/astro-ph/9911223).
- [277] de Blok, W. J. G. & Bosma, A. High-resolution rotation curves of low surface brightness galaxies. *A&A* **385**, 816–846 (2002). [arXiv:astro-ph/0201276](https://arxiv.org/abs/astro-ph/0201276).
- [278] de Blok, W. J. G. *et al.* High-Resolution Rotation Curves and Galaxy Mass Models from THINGS. *AJ* **136**, 2648–2719 (2008). 0810.2100.
- [279] de Blok, W. J. G. & McGaugh, S. S. The dark and visible matter content of low surface brightness disc galaxies. *MNRAS* **290**, 533–552 (1997). [arXiv:astro-ph/9704274](https://arxiv.org/abs/astro-ph/9704274).
- [280] van den Bosch, F. C. & Swaters, R. A. Dwarf galaxy rotation curves and the core problem of dark matter haloes. *MNRAS* **325**, 1017–1038 (2001). [arXiv:astro-ph/0006048](https://arxiv.org/abs/astro-ph/0006048).
- [281] Chemin, L., Carignan, C., Drouin, N. & Freeman, K. C. H I Studies of the Sculptor Group Galaxies. VIII. The Background Galaxies: NGC 24 and NGC 45. *AJ* **132**, 2527–2538 (2006). [arXiv:astro-ph/0609148](https://arxiv.org/abs/astro-ph/0609148).
- [282] Côté, S., Carignan, C. & Freeman, K. C. The Various Kinematics of Dwarf Irregular Galaxies in Nearby Groups and Their Dark Matter Distributions. *AJ* **120**, 3027–3059 (2000).
- [283] Côté, S., Carignan, C. & Sancisi, R. A dark-halo-dominated galaxy - NGC 5585. *AJ* **102**, 904–913 (1991).
- [284] Dutton, A. A., Courteau, S., de Jong, R. & Carignan, C. Mass Modeling of Disk Galaxies: Degeneracies, Constraints, and Adiabatic Contraction. *ApJ* **619**, 218–242 (2005). [arXiv:astro-ph/0310001](https://arxiv.org/abs/astro-ph/0310001).

- [285] Geehan, J. J., Fardal, M. A., Babul, A. & Guhathakurta, P. Investigating the Andromeda stream - I. Simple analytic bulge-disc-halo model for M31. *MNRAS* **366**, 996–1011 (2006). arXiv:astro-ph/0501240.
- [286] Gentile, G., Salucci, P., Klein, U., Vergani, D. & Kalberla, P. The cored distribution of dark matter in spiral galaxies. *MNRAS* **351**, 903–922 (2004). arXiv:astro-ph/0403154.
- [287] Kent, S. M. Dark matter in spiral galaxies. I - Galaxies with optical rotation curves. *AJ* **91**, 1301–1327 (1986).
- [288] Kent, S. M. Dark matter in spiral galaxies. II - Galaxies with H I rotation curves. *AJ* **93**, 816–832 (1987).
- [289] Lake, G. & Feinswog, L. The distribution of dark matter in galaxies. I - Models of spiral galaxies. *AJ* **98**, 166–179 (1989).
- [290] Lake, G., Schommer, R. A. & van Gorkom, J. H. The distribution of dark matter in the dwarf galaxy DDO 170. *AJ* **99**, 547–560 (1990).
- [291] Marchesini, D. *et al.* H α Rotation Curves: The Soft Core Question. *ApJ* **575**, 801–813 (2002). arXiv:astro-ph/0202075.
- [292] Kuzio de Naray, R., McGaugh, S. S., de Blok, W. J. G. & Bosma, A. High-Resolution Optical Velocity Fields of 11 Low Surface Brightness Galaxies. *ApJS* **165**, 461–479 (2006). arXiv:astro-ph/0604576.
- [293] Kuzio de Naray, R., McGaugh, S. S. & de Blok, W. J. G. Mass Models for Low Surface Brightness Galaxies with High-Resolution Optical Velocity Fields. *ApJ* **676**, 920–943 (2008). 0712.0860.
- [294] Puche, D. & Carignan, C. H I studies of the Sculptor group galaxies. VII - Implications on the distribution and nature of dark matter in groups. *ApJ* **378**, 487–495 (1991).
- [295] Sicotte, V. & Carignan, C. NGC 5204: A Strongly Warped Magellanic Spiral.II.H I Kinematics and Mass Distribution. *AJ* **113**, 609–617 (1997).
- [296] Spano, M. *et al.* GHASP: an H α kinematic survey of spiral and irregular galaxies - V. Dark matter distribution in 36 nearby spiral galaxies. *MNRAS* **383**, 297–316 (2008). 0710.1345.
- [297] Swaters, R. A., Madore, B. F., van den Bosch, F. C. & Balcells, M.

The Central Mass Distribution in Dwarf and Low Surface Brightness Galaxies. *ApJ* **583**, 732–751 (2003). arXiv:astro-ph/0210152.

- [298] Tempel, E., Tamm, A. & Tenjes, P. Visible and dark matter in M 31 - II. A dynamical model and dark matter density distribution. *ArXiv e-prints* (2007). 0707.4374.
- [299] Weldrake, D. T. F., de Blok, W. J. G. & Walter, F. A high-resolution rotation curve of NGC 6822: a test-case for cold dark matter. *MNRAS* **340**, 12–28 (2003). arXiv:astro-ph/0210568.
- [300] Frigerio Martins, C. The distribution of the dark matter in galaxies as the imprint of its Nature. *ArXiv e-prints* (2009). 0903.4588.
- [301] <http://sites.google.com/site/dima806/spirals.pdf>.
- [302] van Eymeren, J., Trachternach, C., Koribalski, B. S. & Dettmar, R. Non-circular motions and the cusp-core discrepancy in dwarf galaxies. *A&A* **505**, 1–20 (2009). 0906.4654.
- [303] <http://sites.google.com/site/dima806/dwarves.pdf>.
- [304] Navarro, J. F., Frenk, C. S. & White, S. D. M. The Structure of Cold Dark Matter Halos. *ApJ* **462**, 563–+ (1996). arXiv:astro-ph/9508025.
- [305] Navarro, J. F., Frenk, C. S. & White, S. D. M. A Universal Density Profile from Hierarchical Clustering. *ApJ* **490**, 493–+ (1997). arXiv:astro-ph/9611107.
- [306] Burkert, A. The Structure of Dark Matter Halos in Dwarf Galaxies. *ApJ* **447**, L25+ (1995). arXiv:astro-ph/9504041.
- [307] Macciò, A. V., Dutton, A. A. & van den Bosch, F. C. Concentration, spin and shape of dark matter haloes as a function of the cosmological model: WMAP1, WMAP3 and WMAP5 results. *MNRAS* **391**, 1940–1954 (2008). 0805.1926.
- [308] Springel, V. *et al.* The Aquarius Project: the subhaloes of galactic haloes. *MNRAS* **391**, 1685–1711 (2008). 0809.0898.
- [309] Komatsu, E. *et al.* Five-Year Wilkinson Microwave Anisotropy Probe Observations: Cosmological Interpretation. *ApJS* **180**, 330–376 (2009). 0803.0547.

- [310] Neto, A. F. *et al.* The statistics of Λ CDM halo concentrations. *MNRAS* **381**, 1450–1462 (2007). 0706.2919.
- [311] Bullock, J. S. *et al.* Profiles of dark haloes: evolution, scatter and environment. *MNRAS* **321**, 559–575 (2001). arXiv:astro-ph/9908159.
- [312] Dvali, G., Gabadadze, G. & Porrati, M. 4D gravity on a brane in 5D Minkowski space. *Physics Letters B* **485**, 208–214 (2000). arXiv:hep-th/0005016.
- [313] Kormendy, J. & Djorgovski, S. Surface photometry and the structure of elliptical galaxies. *ARA&A* **27**, 235–277 (1989).
- [314] Tully, R. B. & Fisher, J. R. A new method of determining distances to galaxies. *A&A* **54**, 661–673 (1977).
- [315] Milgrom, M. A modification of the Newtonian dynamics - Implications for galaxies. *ApJ* **270**, 371–389 (1983).
- [316] Loewenstein, M. & Kusenko, A. Dark Matter Search Using Chandra Observations of Willman 1 and a Spectral Feature Consistent with a Decay Line of a 5 keV Sterile Neutrino. *ApJ* **714**, 652–662 (2010). 0912.0552.
- [317] Willman, B. *et al.* A New Milky Way Dwarf Galaxy in Ursa Major. *ApJ* **626**, L85–L88 (2005). arXiv:astro-ph/0503552.
- [318] Loewenstein, M., Kusenko, A. & Biermann, P. L. New Limits on Sterile Neutrinos from Suzaku Observations of the Ursa Minor Dwarf Spheroidal Galaxy. *ApJ* **700**, 426–435 (2009). 0812.2710.
- [319] Riemer-Sørensen, S. & Hansen, S. H. Decaying dark matter in the Draco dwarf galaxy. *A&A* **500**, L37–L40 (2009).
- [320] Piconcelli, E. *et al.* *XMM-Newton Users Handbook, issue 2.10*. ESA: XMM-Newton SOC (2012). http://xmm.esac.esa.int/external/xmm_user_support/documentation/uhb.
- [321] Monte carlo methods for including correlated systematic calibration uncertainties in astrophysical analysis: Chandra acis. http://cxc.harvard.edu/ccr/proceedings/07_proc/presentations/drake/.
- [322] Kerins, E. *et al.* Theory of pixel lensing towards M31 - I. The dens-

- ity contribution and mass of MACHOs. *MNRAS* **323**, 13–33 (2001).
arXiv:astro-ph/0002256.
- [323] Boyarsky, A. *et al.* Searching for dark matter in X-rays: how to check the dark matter origin of a spectral feature. *MNRAS* **407**, 1188–1202 (2010). 1001.0644.
- [324] Dealing with epic out-of-time (oot) events. http://xmm.esa.int/sas/current/documentation/threads/EPIC_OoT.shtml.
- [325] Read, A. M. & Ponman, T. J. The XMM-Newton EPIC background: Production of background maps and event files. *A&A* **409**, 395–410 (2003). arXiv:astro-ph/0304147.
- [326] Nevalainen, J., Markevitch, M. & Lumb, D. XMM-Newton EPIC Background Modeling for Extended Sources. *ApJ* **629**, 172–191 (2005). arXiv:astro-ph/0504362.
- [327] Carter, J. A. & Read, A. M. The XMM-Newton EPIC background and the production of background blank sky event files. *A&A* **464**, 1155–1166 (2007). arXiv:astro-ph/0701209.
- [328] Leccardi, A. & Molendi, S. Radial temperature profiles for a large sample of galaxy clusters observed with XMM-Newton. *A&A* **486**, 359–373 (2008). 0804.1909.
- [329] Kuntz, K. D. & Snowden, S. L. The EPIC-MOS particle-induced background spectra. *A&A* **478**, 575–596 (2008).
- [330] De Luca, A. & Molendi, S. The 2-8 keV cosmic X-ray background spectrum as observed with XMM-Newton. *A&A* **419**, 837–848 (2004). arXiv:astro-ph/0311538.
- [331] `Fin_over_fout` public script, v. 1.1. http://xmm.vilspa.esa.es/external/xmm_sw_cal/background/Fin_over_Fout.
- [332] Repository of xmm-newton epic filter wheel closed (fwc) data. http://xmm2.esac.esa.int/external/xmm_sw_cal/background/filter_closed/index.shtml.
- [333] The ftools webpage. http://heasarc.gsfc.nasa.gov/docs/software/ftools/ftools_menu.html.
- [334] Lumb, D. H., Warwick, R. S., Page, M. & De Luca, A. X-ray background

- measurements with XMM-Newton EPIC. *A&A* **389**, 93–105 (2002). arXiv:astro-ph/0204147.
- [335] Hickox, R. C. & Markevitch, M. Absolute Measurement of the Unresolved Cosmic X-Ray Background in the 0.5-8 keV Band with Chandra. *ApJ* **645**, 95–114 (2006). astro-ph/0512542.
- [336] Moretti, A. *et al.* A new measurement of the cosmic X-ray background. *A&A* **493**, 501–509 (2009). 0811.1444.
- [337] Mateos, S., Saxton, R. D., Read, A. M. & Sembay, S. Statistical evaluation of the flux cross-calibration of the XMM-Newton EPIC cameras. *A&A* **496**, 879–889 (2009). 0901.4026.
- [338] Carter, J. A., Sembay, S. & Read, A. M. A high charge state coronal mass ejection seen through solar wind charge exchange emission as detected by XMM-Newton. *MNRAS* **402**, 867–878 (2010). 0911.0897.
- [339] Guainazzi, M. *et al.* Epic status of calibration and data analysis. XMM-Newton calibration technical report, EPIC Consortium (2012). <http://xmm2.esac.esa.int/docs/documents/CAL-TN-0018.ps.gz>.
- [340] Kirsch, M. G. F. *et al.* XMM-Newton (cross)-calibration. In G. Hasinger & M. J. L. Turner (ed.) *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, vol. 5488 of *Presented at the Society of Photo-Optical Instrumentation Engineers (SPIE) Conference*, 103–114 (2004). astro-ph/0407257.
- [341] Kerins, E. The impact of spheroid stars for Macho microlensing surveys of the Andromeda Galaxy. *Mon. Not. Roy. Astron. Soc.* **347**, 1033 (2004). astro-ph/0310537.
- [342] Kusenko, A. & Loewenstein, M. Searching for dark matter in X-rays: how not to check the dark matter origin of a spectral feature. *ArXiv e-prints* (2010). 1001.4055.
- [343] Walterbos, R. A. M. & Kennicutt, R. C., Jr. Multi-color photographic surface photometry of the Andromeda galaxy. *A&AS* **69**, 311–332 (1987).
- [344] Walterbos, R. A. M. & Kennicutt, R. C., Jr. An optical study of stars and dust in the Andromeda galaxy. *A&A* **198**, 61–86 (1988).

- [345] Bell, E. F., McIntosh, D. H., Katz, N. & Weinberg, M. D. The Optical and Near-Infrared Properties of Galaxies. I. Luminosity and Stellar Mass Functions. *ApJS* **149**, 289–312 (2003). [arXiv:astro-ph/0302543](https://arxiv.org/abs/astro-ph/0302543).
- [346] Bell, E. F. & de Jong, R. S. Stellar Mass-to-Light Ratios and the Tully-Fisher Relation. *ApJ* **550**, 212–229 (2001). [arXiv:astro-ph/0011493](https://arxiv.org/abs/astro-ph/0011493).
- [347] Seigar, M. S., Barth, A. J. & Bullock, J. S. A revised Λ CDM mass model for the Andromeda Galaxy. *MNRAS* **389**, 1911–1923 (2008). [arXiv:astro-ph/0612228](https://arxiv.org/abs/astro-ph/0612228).
- [348] Stanek, K. Z. & Garnavich, P. M. Distance to M31 with the Hubble Space Telescope and HIPPARCOS Red Clump Stars. *ApJ* **503**, L131+ (1998). [arXiv:astro-ph/9802121](https://arxiv.org/abs/astro-ph/9802121).
- [349] Walker, M. G., Mateo, M. & Olszewski, E. W. Stellar Velocities in the Carina, Fornax, Sculptor, and Sextans dSph Galaxies: Data From the Magellan/MMFS Survey. *AJ* **137**, 3100–3108 (2009). 0811.0118.
- [350] Martin, N. F., Ibata, R. A., Chapman, S. C., Irwin, M. & Lewis, G. F. A Keck/DEIMOS spectroscopic survey of faint Galactic satellites: searching for the least massive dwarf galaxies. *MNRAS* **380**, 281–300 (2007). [arXiv:0705.4622](https://arxiv.org/abs/0705.4622).
- [351] Jeltema, T. E. & Profumo, S. Searching for Dark Matter with X-ray Observations of Local Dwarf Galaxies. *ApJ* **686**, 1045–1055 (2008). 0805.1054.
- [352] Xmm-newton epic background components. <http://www.star.le.ac.uk/~amr30/BG/BGTable.html>.
- [353] Pradas, J. & Kerp, J. XMM-Newton data processing for faint diffuse emission. Proton flares, exposure maps and report on EPIC MOS1 bright CCDs contamination. *A&A* **443**, 721–733 (2005). [arXiv:astro-ph/0508137](https://arxiv.org/abs/astro-ph/0508137).
- [354] Mirabal, N. & Nieto, D. Willman 1 in X-rays: Can you tell a dwarf galaxy from a globular cluster? *ArXiv e-prints* (2010). 1003.3745.
- [355] Prokhorov, D. & Silk, J. Can the Excess in the Fe XXVI $\text{Ly}\gamma$ Line from the Galactic Center Provide Evidence for 17 keV Sterile Neutrinos?

- ApJ **725**, L131–L134 (2010). 1001.0215.
- [356] Koyama, K. *et al.* Iron and Nickel Line Diagnostics for the Galactic Center Diffuse Emission. PASJ **59**, 245–255 (2007). arXiv:astro-ph/0609215.
- [357] Riemer-Sørensen, S., Pedersen, K., Hansen, S. H. & Dahle, H. Probing the nature of dark matter with cosmic x rays: Constraints from “dark blobs” and grating spectra of galaxy clusters. Phys. Rev. D **76**, 043524–+ (2007). arXiv:astro-ph/0610034.
- [358] Abazajian, K. N., Markevitch, M., Koushiappas, S. M. & Hickox, R. C. Limits on the radiative decay of sterile neutrino dark matter from the unresolved cosmic and soft x-ray backgrounds. Phys. Rev. D **75**, 063511–+ (2007). arXiv:astro-ph/0611144.
- [359] Yüksel, H., Beacom, J. F. & Watson, C. R. Strong Upper Limits on Sterile Neutrino Warm Dark Matter. *Physical Review Letters* **101**, 121301–+ (2008). 0706.4084.
- [360] Mirabal, N. Swift observation of Segue 1: constraints on sterile neutrino parameters in the darkest galaxy. MNRAS **409**, L128–L131 (2010). 1010.4706.
- [361] Borriello, E., Paolillo, M., Miele, G., Longo, G. & Owen, R. Constraints on sterile neutrino dark matter from XMM-Newton observations of M33. MNRAS **425**, 1628–1632 (2012). 1109.5943.
- [362] Watson, C. R., Li, Z. & Polley, N. K. Constraining sterile neutrino warm dark matter with Chandra observations of the Andromeda galaxy. JCAP **3**, 18 (2012). 1111.4217.
- [363] Loewenstein, M. & Kusenko, A. Dark Matter Search Using XMM-Newton Observations of Willman 1. ApJ **751**, 82 (2012). 1203.5229.
- [364] Combet, C. *et al.* Decaying dark matter: Stacking analysis of galaxy clusters to improve on current limits. Phys. Rev. D **85**, 063517 (2012). 1203.1164.
- [365] Piro, L. *et al.* EDGE: Explorer of diffuse emission and gamma-ray burst explosions. *Experimental Astronomy* **23**, 67–89 (2009). 0707.4103.
- [366] Abazajian, K. Detection of Dark Matter Decay in the X-ray. In *as-*

tro2010: The Astronomy and Astrophysics Decadal Survey, vol. 2010 of *ArXiv Astrophysics e-prints*, 1–+ (2009). 0903.2040.

- [367] Boyarsky, A., Ruchayskiy, O., Iakubovskiy, D., Maccio', A. V. & Malyshev, D. New evidence for dark matter. *ArXiv e-prints* (2009). 0911.1774.
- [368] Merrifield, M. R. The rotation curve of the Milky Way to $2.5 R_0$ from the thickness of the H I layer. *AJ* **103**, 1552–1563 (1992).
- [369] Alcock, C. *et al.* The MACHO Project First-Year Large Magellanic Cloud Results: The Microlensing Rate and the Nature of the Galactic Dark Halo. *ApJ* **461**, 84–+ (1996). arXiv:astro-ph/9506113.
- [370] Battaglia, G. *et al.* Erratum: The radial velocity dispersion profile of the Galactic halo: constraining the density profile of the dark halo of the Milky Way. *MNRAS* **370**, 1055–1056 (2006).
- [371] Smith, M. C. *et al.* The RAVE survey: constraining the local Galactic escape speed. *MNRAS* **379**, 755–772 (2007). arXiv:astro-ph/0611671.
- [372] Xue, X. X. *et al.* The Milky Way's Circular Velocity Curve to 60 kpc and an Estimate of the Dark Matter Halo Mass from the Kinematics of ~2400 SDSS Blue Horizontal-Branch Stars. *ApJ* **684**, 1143–1158 (2008). 0801.1232.
- [373] Sofue, Y., Honma, M. & Omodaka, T. Unified Rotation Curve of the Galaxy – Decomposition into de Vaucouleurs Bulge, Disk, Dark Halo, and the 9-kpc Rotation Dip –. *PASJ* **61**, 227– (2009). 0811.0859.
- [374] Weber, M. & de Boer, W. Determination of the local dark matter density in our Galaxy. *A&A* **509**, A25 (2010). 0910.4272.
- [375] McMillan, P. J. Mass models of the Milky Way. *MNRAS* **414**, 2446–2457 (2011). 1102.4340.
- [376] Haberl, F., Dennerl, K. & Pietsch, W. Deep XMM-Newton observation of a northern LMC field I. Selected X-ray sources. *A&A* **406**, 471–481 (2003). arXiv:astro-ph/0212319.
- [377] Stiele, H. *et al.* The deep XMM-Newton Survey of M 31. *A&A* **534**, A55 (2011). 1106.4755.

- [378] Haberl, F. *et al.* The XMM-Newton survey of the Small Magellanic Cloud. *A&A* **545**, A128 (2012). 1208.0231.
- [379] McConnachie, A. W. *et al.* Distances and metallicities for 17 Local Group galaxies. *MNRAS* **356**, 979–997 (2005). arXiv:astro-ph/0410489.
- [380] Gondolo, P. Dark matter annihilations in the Large Magellanic Cloud. *Nuclear Physics B Proceedings Supplements* **35**, 148–149 (1994). arXiv:astro-ph/9312011.
- [381] Tasitsiomi, A., Gaskins, J. & Olinto, A. V. Gamma-ray and synchrotron emission from neutralino annihilation in the Large Magellanic Cloud. *Astroparticle Physics* **21**, 637–650 (2004). arXiv:astro-ph/0307375.
- [382] Siffert, B. B., Limone, A., Borriello, E., Longo, G. & Miele, G. Radio emission from dark matter annihilation in the Large Magellanic Cloud. *MNRAS* **410**, 2463–2471 (2011). 1006.5325.
- [383] van der Marel, R. P., Alves, D. R., Hardy, E. & Suntzeff, N. B. New Understanding of Large Magellanic Cloud Structure, Dynamics, and Orbit from Carbon Star Kinematics. *AJ* **124**, 2639–2663 (2002). arXiv:astro-ph/0205161.
- [384] Bekki, K. & Stanimirović, S. The total mass and dark halo properties of the Small Magellanic Cloud. *MNRAS* **395**, 342–350 (2009). 0807.2102.
- [385] <http://sites.google.com/site/dima806/galnum.pdf>.
- [386] Heasarc: Nasa’s archive of data on energetic phenomena. <http://heasarc.nasa.gov>.
- [387] <http://sites.google.com/site/dima806/obsnum.pdf>.
- [388] Turner, M. J. L. *et al.* The European Photon Imaging Camera on XMM-Newton: The MOS cameras : The MOS cameras. *A&A* **365**, L27–L35 (2001). arXiv:astro-ph/0011498.
- [389] Strüder, L. *et al.* The European Photon Imaging Camera on XMM-Newton: The pn-CCD camera. *A&A* **365**, L18–L26 (2001).
- [390] Aschenbach, B. *et al.* Imaging performance of the XMM-Newton x-

- ray telescopes. In Truemper, J. E. & Aschenbach, B. (eds.) *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, vol. 4012 of *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, 731–739 (2000). arXiv:astro-ph/0007256.
- [391] de la Calle, I. *et al.* *Users Guide to the XMM-Newton Science Analysis System, issue 9.0*. ESA: XMM-Newton SOC (2012). http://xmm.esac.esa.int/external/xmm_user_support/documentation/sas_usg/USG.
- [392] Xmm-newton science analysis system. <http://xmm.esa.int/sas/>.
- [393] Description of `espfilt` task for xmm-newton science analysis system v. 11.0.0. <http://xmm.esac.esa.int/sas/11.0.0/doc/espfilt/index.html>.
- [394] Abbey, T. *et al.* Micrometeroid Damage to CCDs in XMM-Newton and Swift and its Significance for Future X-ray Missions. In Wilson, A. (ed.) *The X-ray Universe 2005*, vol. 604 of *ESA Special Publication*, 943 (2006).
- [395] Xmm-newton epic mos1 ccd6 update. http://xmm.esac.esa.int/external/xmm_news/items/MOS1-CCD6/.
- [396] Epic source finding thread: `edetect_chain`. http://xmm.esac.esa.int/sas/current/documentation/threads/src_find_thread.shtml.
- [397] Description of `backscale` task for xmm-newton science analysis system v. 11.0.0. <http://xmm.esac.esa.int/sas/11.0.0/doc/backscale/index.html>.
- [398] Description of `evselect` task for xmm-newton science analysis system v. 11.0.0. <http://xmm.esac.esa.int/sas/11.0.0/doc/evselect/index.html>.
- [399] Lumb, D. H., Berthiaume, G. D., Burrows, D. N., Garmire, G. P. & Nousek, J. A. Charge coupled devices (CCDs) in X-ray astronomy. *Experimental Astronomy* **2**, 179–201 (1991).
- [400] Sembay, S. *et al.* In-orbit performance of the EPIC-MOS detectors on XMM-Newton. In G. Hasinger & M. J. L. Turner (ed.) *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, vol. 5488

- of *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, 264–271 (2004). arXiv:astro-ph/0407347.
- [401] Sembay, S. & Bennie, P. Mos ccd rmf description. XMM-Newton calibration technical report (2000). <http://xmm.vilspa.esa.es/docs/documents/CAL-TN-0006-1-0.ps.gz>.
- [402] McCarthy, K. J., Owens, A. & Keay, A. Escape peak ratios in silicon X-ray charge coupled devices (CCDs). *Nuclear Instruments and Methods in Physics Research A* **384**, 403–409 (1997).
- [403] Description of rmfgen task for xmm-newton science analysis system v. 11.0.0. <http://xmm.esac.esa.int/sas/11.0.0/doc/rmfgen/index.html>.
- [404] Description of arfgen task for xmm-newton science analysis system v. 11.0.0. <http://xmm.esac.esa.int/sas/11.0.0/doc/arfgen/index.html>.
- [405] Nazé, Y., Flores, C. A. & Rauw, G. A detailed X-ray investigation of ζ Puppis. I. The dataset and some preliminary results. *A&A* **538**, A22 (2012). 1112.0862.
- [406] Freyberg, M. J. *et al.* EPIC pn-CCD detector aboard XMM-Newton: status of the background calibration. In Flanagan, K. A. & Siegmund, O. H. W. (eds.) *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, vol. 5165 of *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, 112–122 (2004). <http://xmm2.esac.esa.int/docs/documents/CAL-TN-0068-0-1.ps.gz>.
- [407] de Plaa, J. *et al.* Cold fronts and multi-temperature structures in the core of Abell 2052. *A&A* **523**, A81+ (2010). 1008.3109.
- [408] Deslattes, R. D. *et al.* X-ray transition energies: new approach to a comprehensive evaluation. *Reviews of Modern Physics* **75**, 35–99 (2003).
- [409] Arnaud, K. A. XSPEC: The First Ten Years. In Jacoby, G. H. & Barnes, J. (eds.) *Astronomical Data Analysis Software and Systems V*, vol. 101 of *Astronomical Society of the Pacific Conference Series*, 17 (1996).
- [410] Tsunemi, H. *et al.* Development of a large format charge-coupled

- device (CCD) for applications in X-ray astronomy. *Nucl. Instr. and Methods in Phys. Research A* **579**, 866–870 (2007).
- [411] Porter, F. Low-temperature detectors in x-ray astronomy. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* **520**, 354 – 358 (2004).
- [412] McCammon, D. *Thermal Equilibrium Calorimeters - An Introduction*, 1 (2005).
- [413] Takahashi, T. *et al.* The ASTRO-H Mission. In *Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series*, vol. 7732 of *Presented at the Society of Photo-Optical Instrumentation Engineers (SPIE) Conference* (2010). 1010.4972.
- [414] den Herder, J.-W. *et al.* ORIGIN: metal creation and evolution from the cosmic dawn. *Experimental Astronomy* **30** (2011). 1104.2048.
- [415] Barcons, X. *et al.* Athena (Advanced Telescope for High ENergy Astrophysics) Assessment Study Report for ESA Cosmic Vision 2015-2025 (2012). 1207.2745.
- [416] Kelley, R. L. *et al.* The Suzaku High Resolution X-Ray Spectrometer. *PASJ* **59**, 77–112 (2007).
- [417] <http://astro-h.isas.jaxa.jp/index.html.en>.
- [418] McCammon, D. *et al.* A High Spectral Resolution Observation of the Soft X-Ray Diffuse Background with Thermal Detectors. *ApJ* **576**, 188–203 (2002). arXiv:astro-ph/0205012.
- [419] Markevitch, M. *et al.* Chandra Spectra of the Soft X-Ray Diffuse Background. *ApJ* **583**, 70–84 (2003). astro-ph/0209441.
- [420] Landau, L. D. & Lifshitz, E. M. *Statistical physics. Pt.1, Pt.2* (Course of theoretical physics, Pergamon International Library of Science, Technology, Engineering and Social Studies, Oxford: Pergamon Press, 1980—c1980, 3rd rev.and enlarg. ed., 1980).
- [421] Henley, D. B. & Shelton, R. L. An XMM-Newton Survey of the Soft X-ray Background. I. The O VII and O VIII Lines Between $l = 120^\circ$ and $l = 240^\circ$. *ApJS* **187**, 388–408 (2010). 1002.4631.

[422] Henley, D. B. & Shelton, R. L. An XMM-Newton Survey of the Soft X-Ray Background. II. An All-Sky Catalog of Diffuse O VII and O VIII Emission Intensities. *ApJS* **202**, 14 (2012). 1208.4360.