

## Homework Set #5 [Final]

### *Instructions:*

The last homework will consist of a short individual seminar on a topic relevant for the material discussed in the Course.

You can choose any of the topics listed below. Every topic has more than one Reference, that should be considered as a possible starting point for your literature search project. The talks will be 25 minutes long (strictly enforced) plus 5 minutes for questions, and will take place in ISB 310, on Monday December 8 and Tuesday December 9. You can choose to prepare either a “blackboard talk” type seminar, or a slide presentation (a video projector will be available).

E-mail the instructor (CC'ing all other students) with your choices. Within reason, the criterion for the assignment of the topics and time slots will be “first come, first serve”, based on the receipt of your e-mails. If you do not make any choice before November 27, the Instructor will assign you a topic and time slot.

### *List of Proposed Topics:*

1. Leptonic versus Hadronic models of Gamma-Ray Emission in Active Galactic Nuclei [*suggested by A. Furniss*]  
*References:* [1], chapters 8 and 10, and references therein
2. Quark Matter in Neutron Stars [*suggested by H. Cambier*]  
*References:* [2, 3, 4, 5, 6, 7]
3. Universal Extra Dimensions at Colliders [*suggested by P. Manning*]  
*References:* [8]
4. Cosmological Weakly Interacting Massive Particle Dark Matter Annihilation [*suggested by L. Pack*]  
*References:* [9, 10, 11, 12]

5. Higgs searches with the Tevatron Run-II and new physics interpretations of the recently reported multi-muon events  
*References:* [13, 14, 15, 16, 17, 18]
6. Higgs searches with the Large Hadron Collider and with an International Linear Collider  
*References:* [19, 13, 20, 21, 22, 23, 14]
7. Leptonic CP violation and Neutrino Factories  
*References:* [24, 25, 26, 27, 15]
8. Neutrino masses and mixing: current status and prospects  
*References:* [28, 29, 30, 31, 32, 15]
9. Experimental and theoretical overview of Pentaquarks  
*References:* [33, 34, 35, 36, 37, 15]
10. Status and prospects of proton decay searches, and impact on Grand Unification models  
*References:* [38, 39, 40, 41, 42, 43, 15]
11. Monopole searches: current status, prospects and overview of the constraints on Grand Unification and Inflation models  
*References:* [44, 45, 46, 47, 48, 49, 50, 51, 15]
12. Gauge coupling unification in the Standard Model, in its supersymmetric extensions and in other beyond the Standard Model frameworks  
*References:* [41, 52, 53, 54, 55, 15]
13. Overview of baryogenesis models and status of GUT baryogenesis  
*References:* [56, 57, 58, 59, 51]
14. Axion models and cosmological axion production mechanisms  
*References:* [60, 61, 62, 63, 64, 51, 15]
15. Axion search experiments and astrophysical constraints  
*References:* [60, 65, 62, 63, 64, 66, 67, 51, 15]

## References

- [1] F. A. Aharonian, *Very High Energy Cosmic Gamma Radiation*, World Scientific, 2004.
- [2] M. Prakash, *J. Phys. G* **34** (2007) S253 [arXiv:0704.0207 [astro-ph]].
- [3] V. Soni and D. Bhattacharya, *Phys. Lett. B* **643** (2006) 158.
- [4] P. Jaikumar, S. Reddy and A. W. Steiner, *Mod. Phys. Lett. A* **21** (2006) 1965 [arXiv:astro-ph/0608345].
- [5] T. Endo, T. Maruyama, S. Chiba and T. Tatsumi, arXiv:hep-ph/0502216.
- [6] Weber, F. 1999, *Journal of Physics G Nuclear Physics*, 25, 195
- [7] Chapline, G., & Nauenberg, M. 1977, *Phys. Rev. D* , 16, 450
- [8] D. Hooper and S. Profumo, *Phys. Rept.* **453**, 29 (2007) [arXiv:hep-ph/0701197].
- [9] G. Bertone, D. Hooper and J. Silk, *Phys. Rept.* **405**, 279 (2005) [arXiv:hep-ph/0404175].
- [10] L. Bergstrom, J. Edsjo and P. Ullio, *Phys. Rev. Lett.* **87**, 251301 (2001) [arXiv:astro-ph/0105048].
- [11] P. Ullio, L. Bergstrom, J. Edsjo and C. G. Lacey, *Phys. Rev. D* **66**, 123502 (2002) [arXiv:astro-ph/0207125].
- [12] S. Colafrancesco, S. Profumo and P. Ullio, *Astron. Astrophys.* **455**, 21 (2006) [arXiv:astro-ph/0507575].
- [13] M. S. Carena *et al.* [Higgs Working Group Collaboration], arXiv:hep-ph/0010338.
- [14] “The Higgs Hunter’s Guide” by John F. Gunion, Howard E. Haber, Sally Dawson, Westview Press.
- [15] W. M. Yao *et al.* [Particle Data Group], *J. Phys. G* **33**, 1 (2006) [<http://pdg.lbl.gov/>]
- [16] T. Aaltonen *et al.* [CDF Collaboration], *Phys. Rev. D* **77** (2008) 072004 [arXiv:0710.1895 [hep-ex]].
- [17] T. Aaltonen *et al.* [CDF Collaboration], arXiv:0810.5357 [hep-ex].
- [18] P. Giromini, F. Happacher, M. J. Kim, M. Kruse, K. Pitts, F. Ptohos and S. Torre, arXiv:0810.5730 [hep-ph].
- [19] M. Spira, A. Djouadi, D. Graudenz and P. M. Zerwas, *Nucl. Phys. B* **453** (1995) 17 [arXiv:hep-ph/9504378].
- [20] D. Zeppenfeld, R. Kinnunen, A. Nikitenko and E. Richter-Was, *Phys. Rev. D* **62** (2000) 013009 [arXiv:hep-ph/0002036].

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- [21] M. Dittmar and H. K. Dreiner, Phys. Rev. D **55** (1997) 167 [arXiv:hep-ph/9608317].
- [22] M. Battaglia, T. Barklow, M. E. Peskin, Y. Okada, S. Yamashita and P. M. Zerwas, *In the Proceedings of 2005 International Linear Collider Workshop (LCWS 2005), Stanford, California, 18-22 Mar 2005, pp 1602* [arXiv:hep-ex/0603010].
- [23] T. L. Barklow, arXiv:hep-ph/0411221.
- [24] T. I. P. Group, arXiv:0710.4947 [hep-ph].
- [25] W. Marciano and Z. Parsa, arXiv:hep-ph/0610258.
- [26] C. H. Albright *et al.* [Neutrino Factory/Muon Collider Collaboration], arXiv:physics/0411123.
- [27] Z. Parsa, AIP Conf. Proc. **549** (2002) 781.
- [28] S. M. Bilenky, C. Giunti, J. A. Grifols and E. Masso, Phys. Rept. **379** (2003) 69 [arXiv:hep-ph/0211462].
- [29] T. Schwetz, Acta Phys. Polon. B **36** (2005) 3203 [arXiv:hep-ph/0510331].
- [30] T. Schwetz, arXiv:0710.5027 [hep-ph].
- [31] M. Maltoni, T. Schwetz, M. A. Tortola and J. W. F. Valle, New J. Phys. **6** (2004) 122 [arXiv:hep-ph/0405172].
- [32] M. Apollonio *et al.*, arXiv:hep-ph/0210192.
- [33] F. Stancu and D. O. Riska, Phys. Lett. B **575** (2003) 242 [arXiv:hep-ph/0307010].
- [34] N. Mathur *et al.*, Phys. Rev. D **70** (2004) 074508 [arXiv:hep-ph/0406196].
- [35] M. Danilov and R. Mizuk, arXiv:0704.3531 [hep-ex].
- [36] K. H. Hicks, Acta Phys. Polon. B **35** (2004) 3039.
- [37] K. Goeke, H. C. Kim, M. Praszalowicz and G. S. Yang, Prog. Part. Nucl. Phys. **55** (2005) 350 [arXiv:hep-ph/0411195].
- [38] M. Shiozawa *et al.* [Super-Kamiokande Collaboration], Phys. Rev. Lett. **81**, 3319 (1998) [arXiv:hep-ex/9806014].
- [39] Y. Hayato *et al.* [Super-Kamiokande Collaboration], Phys. Rev. Lett. **83**, 1529 (1999) [arXiv:hep-ex/9904020].
- [40] Y. Suzuki *et al.* [TITAND Working Group], arXiv:hep-ex/0110005.
- [41] P. Langacker, Phys. Rept. **72** (1981) 185.
- [42] S. Dimopoulos, S. Raby and F. Wilczek, Phys. Lett. B **112** (1982) 133.
- [43] P. Nath and P. F. Perez, Phys. Rept. **441** (2007) 191 [arXiv:hep-ph/0601023].

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- [44] M. Ambrosio *et al.* [MACRO Collaboration], *Eur. Phys. J. C* **25** (2002) 511 [arXiv:hep-ex/0207020].
- [45] M. Cozzi, *Phys. Atom. Nucl.* **70** (2007) 118 [arXiv:hep-ex/0703014].
- [46] K. A. Milton, *Rept. Prog. Phys.* **69** (2006) 1637 [arXiv:hep-ex/0602040].
- [47] A. H. Guth and S. H. H. Tye, *Phys. Rev. Lett.* **44**, 631 (1980) [Erratum-*ibid.* **44**, 963 (1980)].
- [48] A. H. Guth, *Phys. Rev. D* **23** (1981) 347.
- [49] A. Albrecht and P. J. Steinhardt, *Phys. Rev. Lett.* **48** (1982) 1220.
- [50] K. A. Olive, *Phys. Rept.* **190** (1990) 307.
- [51] E.W. Kolb and M.S. Turner, “The Early Universe”, Addison-Wesley, Reading, MA (1990).
- [52] J. R. Ellis, S. Kelley and D. V. Nanopoulos, *Phys. Lett. B* **260** (1991) 131.
- [53] A. E. Faraggi, *Phys. Lett. B* **302** (1993) 202 [arXiv:hep-ph/9301268].
- [54] L. E. Ibanez, *Phys. Lett. B* **318** (1993) 73 [arXiv:hep-ph/9308365].
- [55] W. de Boer, *Prog. Part. Nucl. Phys.* **33** (1994) 201 [arXiv:hep-ph/9402266].
- [56] M. Dine and A. Kusenko, *Rev. Mod. Phys.* **76** (2004) 1 [arXiv:hep-ph/0303065].
- [57] W. Buchmuller, arXiv:0710.5857 [hep-ph].
- [58] E. W. Kolb and M. S. Turner, *Ann. Rev. Nucl. Part. Sci.* **33** (1983) 645.
- [59] E. Witten, arXiv:hep-ph/0207124.
- [60] M. S. Turner, *Phys. Rept.* **197** (1990) 67.
- [61] L. F. Abbott and P. Sikivie, *Phys. Lett. B* **120** (1983) 133.
- [62] G. G. Raffelt, *Phys. Rept.* **198** (1990) 1.
- [63] G. G. Raffelt, “Stars As Laboratories For Fundamental Physics: The Astrophysics Of Neutrinos, Axions, And Other Weakly Interacting Particles,” *Chicago, USA: Univ. Pr. (1996) 664 p*
- [64] G. G. Raffelt, *J. Phys. A* **40** (2007) 6607 [arXiv:hep-ph/0611118].
- [65] P. Sikivie, *Phys. Rev. Lett.* **51** (1983) 1415 [Erratum-*ibid.* **52** (1984) 695].
- [66] K. Zioutas *et al.* [CAST Collaboration], *Phys. Rev. Lett.* **94** (2005) 121301 [arXiv:hep-ex/0411033].
- [67] G. G. Raffelt and D. S. P. Dearborn, *Phys. Rev. D* **36** (1987) 2211.