

## 1 Axion-photon

### Haloscopes

- ABRACADABRA [1, 2]
- ADMX [3, 4, 5, 6]
- ADMX-Sidecar [7, 8]
- ADMX-SLIC [9]
- CAPP [10, 11, 12, 13, 14, 15]
- CAST-CAPP [16]
- DANCE [17]
- BASE [18]
- GrAHal [19]
- HAYSTAC [20, 21, 22]
- LIDA [23]
- ORGAN [24, 25]
- QUAX [26, 27, 28]
- RADES [29]
- RBF [30]
- SHAFT [31]
- TASEH [32]
- SuperMAG [33]
- UF [34]
- UPLOAD-DOWNLOAD [35, 36]
- ABRACADABRA (projection) [37]
- ADBC (projection) [38]
- ADMX (projection) [39]
- aLIGO (projection) [40]
- ALPHA (projection) [41, 42]
- BabyIAXO-RADES (projection) [43]
- BRASS (projection) [44]
- BREAD (projection) [45]
- CADEX (projection) [46]
- DALI (projection) [47]
- DM-Radio (projection) [48, 49]
- DANCE (projection) [50]
- LAMPOST (projection) [51]
- MADMAX (projection) [52]
- FLASH (projection) [53, 54]
- QUAX (projection) [55]
- ORGAN (projection) [24]
- TOORAD (projection) [56]
- Twisted Anyon Cavity (projection) [57]
- WISPLC (projection) [58]
- WISPLC (projection) [59]
- SRF heterodyne cavity (projection) [60]

### LSW/Helioscopes

- ALPS [61]
- CAST [62, 63]
- CROWS [64]
- OSQAR [65]
- PVLAS [66]
- SAPPHIRES [67, 68]
- ALPS-II (projection) [69]
- IAXO (projection) [70]
- IAXO (Galactic SN) [71]

### Astro

- Axion star explosions [72]
- Betelgeuse [73]
- BICEP/KECK [74]
- Breakthrough Listen (Doppler shifted radio line in MW) [75]
- Bullet Cluster (archival radio data) [76]
- Cosmic IR background (hint) [77]
- Chandra (Hydra) [78]
- Chandra (M87) [79]
- Chandra (NG7 1275) [80]
- Chandra (H1821+643) [81]
- CMB Anisotropies [82, 83]
- COBE/FIRAS+Planck spectral dist. [84]
- Diffuse gamma-rays [85]
- Diffuse SN ALPs [86] (see also [87])
- Distance ladder [88]

- Fermi-LAT (NGC 1275) [89]
- Fermi-LAT (Extragalactic SNe) [90]
- Fermi-LAT (Quasars) [91]
- Gamma-ray attenuation (ALP dark matter) [92]
- Globular clusters ( $R$  parameter) [93]
- Globular clusters ( $R_2$  parameter) [94]
- HAWC (TeV Blazars) [95]
- HESS (PKS 2155-304) [96]
- INTEGRAL (ALP decay) [97]
- Leo T gas temperature [98]
- Magnetic white dwarfs (X-rays) [99]
- Magnetic white dwarf (polarization) [100]
- MOJAVE [101]
- Mrk 421 (ARGO-YBJ+Fermi): [102]
- Mrk 421 (ARGO-YBJ+MAGIC): [103]
- Neutron Stars (Foster et al. 2020) [104]
- Neutron Stars (Darling 2020) [105]
- Neutron Stars (Battye et al. 2021) [106]
- Neutron stars (Foster et al. 2022) [107]
- Neutron Stars (Battye et al. 2023) [108]
- NuSTAR (decaying dark matter, recast from Sterile nu) [109, 110, 111]
- Planck cosmic birefringence [112]
- POLARBEAR [113]
- PPTA+QUIJOTE [114]
- Pulsar polarisation arrays (projection) [115]
- Pulsar polar cap [116]
- Red supergiant [117]
- Solar neutrinos [118]
- Stellar axion background [119]
- SN1987A- $\gamma$  (ALP decay) [120, 121, 122]
- SN1987A- $\gamma$  (low mass ALP conversion) [123, 121]
- SN1987A- $\gamma, \nu$  (high mass ALPs) [124, 125, 85]
- SN1987A (PVO) [126]
- Low-energy supernovae (ALP decay) [85]
- Solar basin (NuSTAR) [127]
- Solar basin (NuSTAR and SPHINX) [128]
- Star clusters [129]
- SPT [130]
- Telescopes (Haystack) [131]
- Telescopes (MUSE) [132] (updated from: [133])
- Telescopes (VIMOS) [134]
- Telescopes (HST) [135, 136]
- Fermi galactic SN (projection) [137]
- THESEUS (projection) [138]
- WINERED (projection) [139]
- eROSITA (projection) [140]
- White dwarf initial-final mass relation [141]
- XMM-Newton (decaying DM ALPs) [142]

### Cosmology

- Ionisation fraction, EBL, X-rays [143]
- BBN+ $N_{\text{eff}}$  [144]
- Freeze in [145]

## 2 Heavy ALP-photon coupling

- ATALS (PbPb) [146]
- BaBar [147]
- Beam dump [148, 149, 147, 150, 151]
- Belle II [152]
- BESIII [153]
- CMS (PbPb) [154]
- LEP [155]
- LHC (pp)[156]
- MiniBooNE [157]
- NOMAD [158]
- OPAL [156]
- PrimEx [159, 160]
- CONUS (projection) [161]
- DUNE (projection) [162]
- FASER LLP (projection) [163]

## 3 Axion-electron

- EDELWEISS [164]
- Magnon non-demolition [165]
- DarkSide-50 [166]
- GERDA [167]
- LUX [168]
- Panda-X [169]
- SuperCDMS [170]
- XENON1T [171, 172]
- XENONnT [173]
- XENON1T (Solar basin) [174]
- Red giants ( $\omega$ Cen) [175]
- NV Centers (projection) [176]
- Solar neutrinos [177]
- Magnons (projection) [178]
- Polaritons (projection) [179]
- DARWIN (projection) [180]
- LZ (projection) [181]
- QUAX [182, 183]
- Semiconductors (projection) [184]
- White dwarf hint [185]
- Freeze-in irreducible axions [145]
- X-rays (1-loop decay) [186]

## 4 Axion-nucleon

Note: CASPER and nEDM limits account for stochastic correction reported in [187]

- Casimir effect (fifth force) [188]
- CASPER-ZULF-Comagnetometer [189]
- CASPER-ZULF-Sidechain [190]
- ChangE [191]
- Hefei Spin-based amplifiers [192]
- nEDM (ultracold neutrons and mercury) [193]
- NASDUCK [194, 195]
- PSI HgM (nEDM) [196]
- K-3He comagnetometer (fifth force) [197]
- K-3He comagnetometer (dark matter) [198]
- JEDI [199]
- Old comagnetometers [200]
- Torsion balance [201]
- Neutron star cooling [202] (corrected from [203])
- SN1987A Cooling [204, 205]
- SNO (deuterium dissasociation) [206]
- Proton storage ring (projection) [207]
- Electrostatic storage ring (projection) [208]
- DM comagnetometer (projection) [200]
- CASPER-gradient (projection) [190]
- Superfluid helium-3 HPD (projection) [209]

## 5 Axion-EDM

- Axinovae [210]
- Beam EDM [211]
- BBN (dark matter) [212]
- CASPER-electric [213]
- nEDM [193]
- $\text{HfF}^+$  [214]
- JEDI [199]
- Rb/Quartz [215]
- SN1987A [216]
- *Planck*+BAO thermal axion bound [217]
- CASPER-electric (projection) [218]
- Storage Ring EDM (projection) [218]

## 6 Axion mass versus $f_a$

- BBN (dark matter) [212]
- Beam EDM [211]
- Binary pulsars and Solar core constraint on  $\bar{\theta}$  [219]. I include minor numerical corrections made by [220, 221].
- GW170817 [222]
- $\text{HfF}^+$  [214]
- Rb/Quartz [215]
- JEDI [199]
- nEDM [193]
- Piezoaxionic effect (projection) [223]
- *Planck*+BAO thermal axion bound [217]
- SN1987A [216]
- Neutron stars (projection) [219].
- NS-NS and NS-BH Inspirals (projection) [219].
- White dwarfs [224]

### 6.1 Black hole superradiance

- Baryakhtar et al. [225] (just Stellar mass BHs)
- Mehta et al. [225] (Stellar mass and SMBHs)
- Stott [226]
- Ünal et al. [227] (Quasars)
- Cardoso et al. [228] (dark photon)

## 7 Axion theory predictions

### 7.1 Post-inflation QCD axion

- Ballesteros et al. [229]
- Buschmann et al. 2020 [230]
- Buschmann et al. 2021 [231]
- Bonati et al. [232]
- Borsanyi et al. [233]
- Berkowitz et al. [234]
- Dine et al. [235]
- Petreczky et al. [236]
- Fleury & Moore [237]
- Klaer & Moore [238]
- Gorghetto et al. [239]
- Saikawa et al. [70]

### 7.2 Other dark matter predictions

- ALP Cogenesis [240]
- Early matter domination [241]
- Post-inflation ALP misalignment [242, 243]
- Trapped misalignment ( $\mathcal{Z}_N$  axion) [220]

## 8 CP-violating couplings

Combined constraints [244]

### Scalar-nucleon

- Red giants [245]
- MICROSCOPE [246].
- Eot-Wash [247, 248, 249]
- Irvine [250]. Corrected to  $2\sigma$  limit by [251]
- HUST [252, 253, 254, 255].
- Stanford [256]
- IUPUI [257].
- Wuhan [251]

### Pseudoscalar-electron

- Red giants [245]
- Eot-wash [258]
- NIST [259]
- SMILE [260].
- QUAX [261, 262, 263]
- Washington [264, 265].
- XENON1T [266]
- Magnon (projection) [179]
- QUAX (projection) [261].

### Pseudoscalar-nucleon

- Neutron star cooling [202]
- Hefei (Earth) [267]
- Hefei (mm) [268]
- Washington [269]. Limit taken from [270].
- SMILE [260].
- Mainz [271]
- Moon/Sun [272]
- ARIADNE (projection) [273]
- CASPEr-wind (projection) [218]
- DM comagnetometer (projection) [200]
- Fifth force Ne-Rb-K comagnetometer (projection) [274]

## 9 Scalars

### Scalar-photon

- Globular clusters [94]
- Eot-Wash (EP) [275]
- Fifth force [276, 277, 278, 279]
- MICROSCOPE [246]
- AURIGA [280]
- BACON [281]
- Cs/Cav [282]
- DAMNED [283]
- Dy/Dy [284]
- Dy/Quartz [215]
- Dynamic Decoupling [285]
- GEO600 [286]
- LIGO O3 [287]
- Holometer [288]
- H/Quartz/Sapphire [289]
- PTB (Yb+, Sr clock) [290]
- I<sub>2</sub> [291]
- Rb/Cs [292]
- Sr/Si [293]
- Yb/Sr [294]
- AEDGE (projection) [295]
- AION (projection) [295]
- DUAL (projection) [296]
- MAGIS (projection) [297]
- Nuclear clock (projection) [298]
- Mechanical Resonators (projection) [299]

### Scalar-electron

- Red giants [245]
- White dwarfs [300]
- Eot-Wash (EP) [275]
- Fifth force [276, 277, 278, 279]
- MICROSCOPE [246]
- AURIGA [280]
- Cs/Cav [282]
- DAMNED [283]
- GEO600 [286]
- Holometer [288]
- H/Quartz/Sapphire [289]
- I<sub>2</sub> [291]
- H/Si [293]
- Rb/Quartz [215]
- Yb/Cs [301]
- LIGO O3 [287]
- NANOGrav 15-year PTA [302]
- FOCOS (nuclear clock projection) [303]
- AEDGE (projection) [295]
- AION (projection) [295]
- DUAL (projection) [296]
- Optical microwave clock (projection) [304]
- Optical cavities [305]
- SrOH [306]
- Mechanical Resonators (projection) [299]
- IPTA (mock data) [307]

## 10 Vectors

### B-L coupling

- Casimir [308, 309, 310]
- Eot-Wash (EP) [311]
- Eot-Wash (ISL) [312]
- MICROSCOPE [313]
- DM stability [314]
- Horizontal branch [245]
- Sun [245]
- Eot-Wash (DM) [315]
- LIGO (O1) [316]
- LIGO/VIRGO [316]
- LISA Pathfinder [317]
- PPTA [318]
- Asteroids (projection) [319]
- LISA (projection) [319]
- MAGIS (projection) [297]
- Optomechanical membranes (projection) [320]
- SKA (projection) [321]
- Torsion balance (projection) [321]
- STE-QUEST (projection) [322]

## 11 Dark photons

Combined constraints [323]

### SM photon-DP transitions

- Coulomb [324, 325, 326, 327, 328],
- Plimpton & Lawton’s experiment [329, 328]
- Atomic spectroscopy [330]
- Atomic force microscopy (AFM) [328]
- Static magnetic field of the Earth [331, 332, 333]
- Static magnetic field of Jupiter [334, 333].
- ALPs [61]
- ALPS-II (projection) [335]
- SPring-8 [336]
- UWA-LSW [337, 338]
- ADMX-LSW [339]
- CROWS [64].
- DarkSRF [340]
- DarkSRF (projection) [341]
- TEXONO [342]
- Crab nebula [343]
- COBE and FIRAS [344]
- STAX (projection) [345]

### Production in stars

- CAST [346]
- SHIPS [347]
- HINODE [348]
- New globular cluster bound [349]
- Old stellar bounds: Solar-L, HB and RG stars [350] (see also [351])
- Neutron stars [352]
- Solar neutrinos [353]
- XENON1T [354]

### Dark matter cosmology/astro

- Arias et al. [242]
- Witte et al. [355, 356]
- Caputo et al. [357, 344],
- ISM [358],
- Leo T dwarf [359]
- Gas clouds [359, 360]

### Dark matter experiments

- Reinterpreted axion limits [323]
- ALPHA [42]
- AMAILS [361]
- BRASS-p [362]
- BREAD (projection) [45]
- DarkSide-50 [166]
- DAMIC [363]
- Dark E-field Radio [364]
- DM Pathfinder [365]
- DOSUE-RR [366]
- FAST Radio antenna [367]
- FUNK [368]
- LAMPOST [369]
- LOFAR (solar corona) [370]
- MuDHI [371]
- ORGAN [372]
- ORPHEUS [373]
- QUALIPHIDE [374]
- Quantum cyclotron [375]
- SENSEI [376]
- SHUKET [377]
- SuperCDMS [378]
- SuperMAG [379, 380]
- SQuAD [381],
- SQMS [382],
- SRF scanning [383]
- Tokyo dish antennae experiments [384, 385, 386]
- WISPDMS [387]
- XENON(100,1T,nT) [184, 266, 388, 389, 354, 390].

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