# NASA'S NEWEST X-RAY EYES: AN UPDATE ON THE IMAGING X-RAY POLARIMETRY EXPLORER (IXPE)"

**Martin C. Weisskopf**
**IXPE Principal Investigator**
**NASA/Marshall Space Flight Center**

**Presentation to the AAS**
**Monday, January 10, 2022**

# IXPE Successfully Launched on a Falcon 9 on December 9, 2021

IXPE Imaging X-Ray Polarimetry Explorer

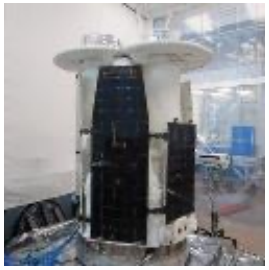
**Equatorial orbit**
**600 km altitude**

# IXPE Commissioning Successfully Completed

- Solar panels deployed
- Boom deployed

- All spacecraft functions activated and verified
- Polarization-sensitive detectors activated and used to view on-board polarized and unpolarized calibration sources
- Final telescope (optics + detector) alignments checked and adjusted viewing the X-ray source 1ES 1959+650

# IXPE Observatory

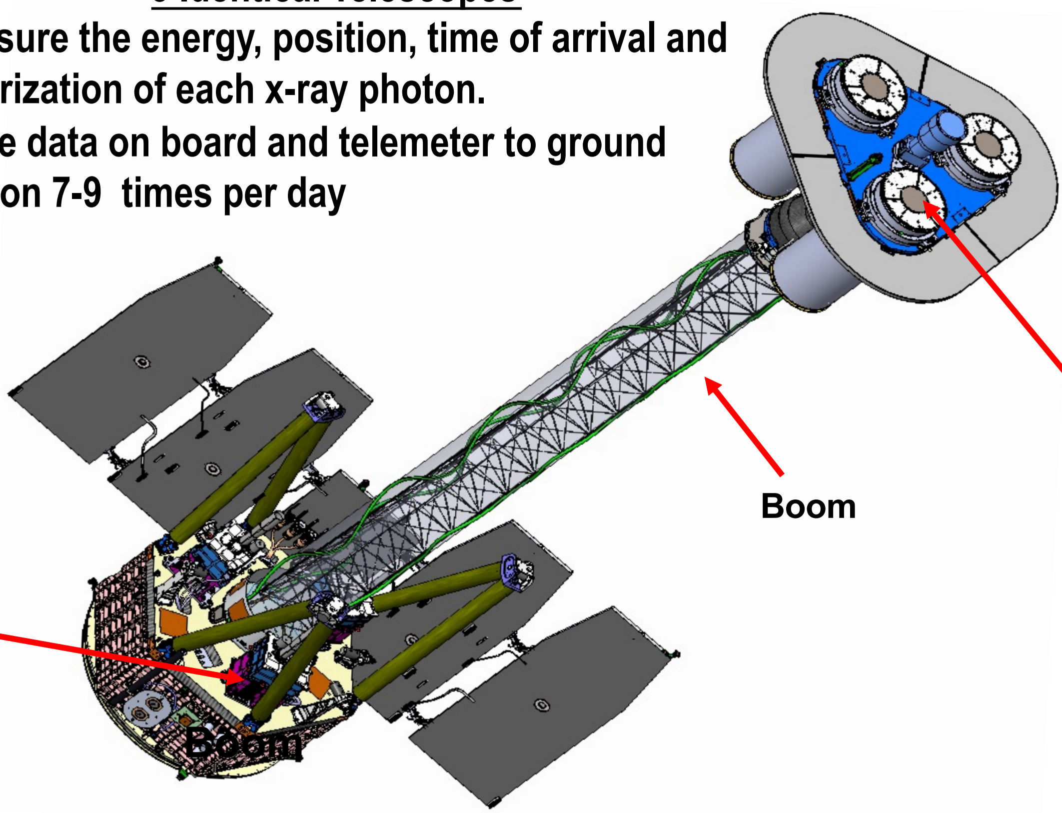


Stowed

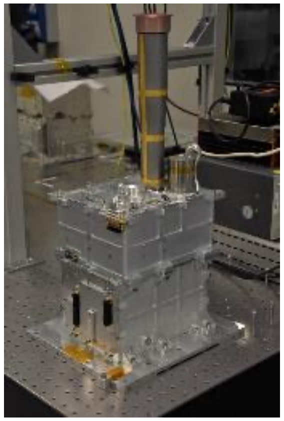
**3 Identical Telescopes**

Measure the energy, position, time of arrival and polarization of each x-ray photon.
Store data on board and telemeter to ground station 7-9 times per day

Deployed

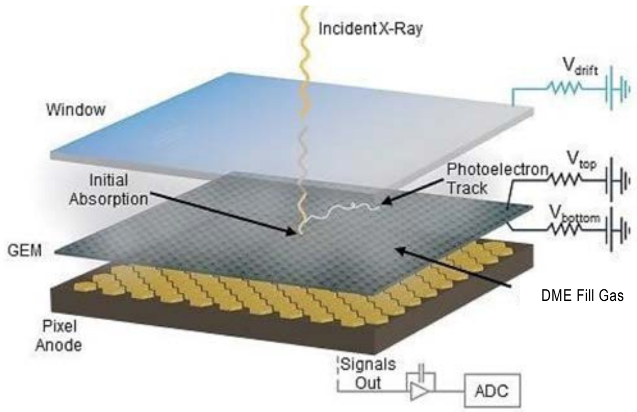



Detector Units (3)

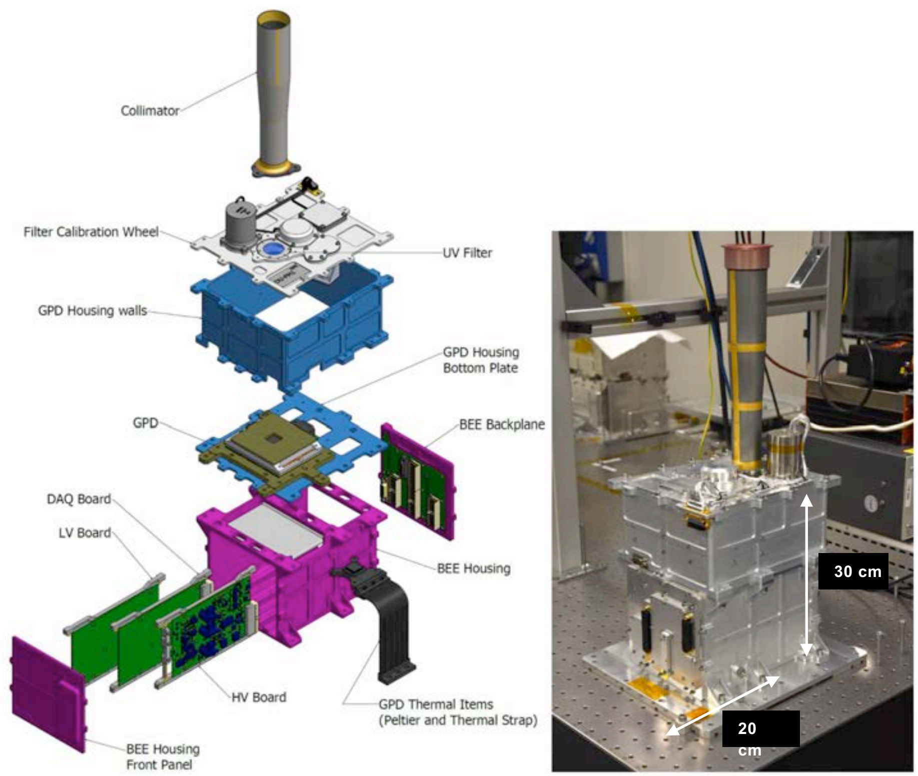


Mirror Module Assemblies (3)

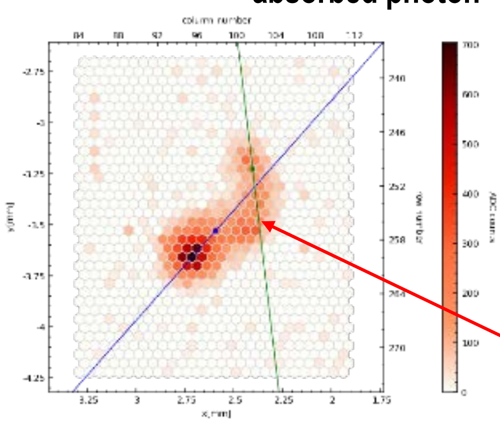
# Polarization-Sensitive Detectors Developed in Italy




**The gas pixel detector (GPD), the heart of the detector unit, tracks photoelectrons to measure the polarization angle of the absorbed photon**




(a) (b)



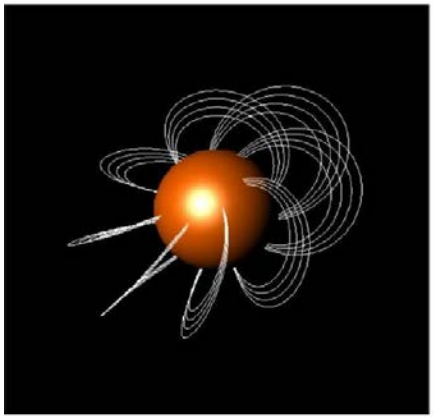

**Photoelectron Track**
**Reconstructed interaction point (green dot) and emission direction (green line)**

# First Year Observations

- OBJECTIVE 1: Active Galactic Nuclei (AGN)
  - ✓ Obtain polarimetry of three (3) AGN to look for a correlation of polarization direction with the orientation of the AGN radio structure. [15]
- OBJECTIVE 2: Microquasars (μ-Quasars)
  - ✓ Obtain spectral polarimetry of two (2) microquasars to constrain the value of the black-hole spin parameter, in combination with information on the radio structure. [2]
- OBJECTIVE 3: Radio Pulsars and Pulsar-Wind Nebulae (PWNe)
  - ✓ Obtain polarimetric imaging of one (1) Pulsar Wind Nebula (PWNe) to constrain the magnetic-field geometry of the nebula and the phase-dependent polarization of the pulsar. [3]
- OBJECTIVE 4: Supernova Remnants (SNR)
  - ✓ Obtain spectral polarimetric imaging of one (1) Supernova Remnant (SNR) to constrain the magnetic-field structure of the X-ray emitting regions. [3]
- OBJECTIVE 5: Magnetars
  - ✓ Obtain phase-dependent polarimetry of one (1) magnetar to constrain the effects of vacuum polarization (birefringence in a strong magnetic field). [2]
- OBJECTIVE 6: Accreting X-ray Pulsars
  - ✓ Obtain phase-dependent polarimetry of three (3) classical accreting X-ray pulsars (high-magnetic-field binaries) to constrain models and geometries for the pulsing emission. Obtain polarimetry of two (2) millisecond X-ray pulsars (low-magnetic-field binaries) to constrain the geometry of the accretion-disk system. [8]

***IXPE Year-1 observing plan:*** *33 planned targets, plus 36 days for ~6 transients or other targets of opportunity*

# Magnetars: A  Long-Searched Vacuum-Birefringence QED Effect



**Folgerungen aus der Diracschen Theorie des Positrons.**

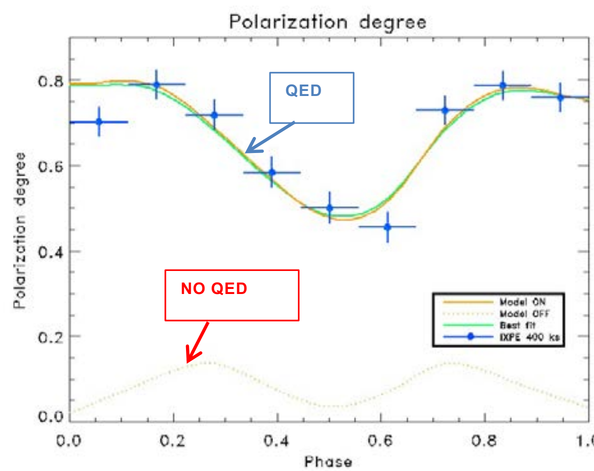
Von **W. Heisenberg** und **H. Euler** in Leipzig.

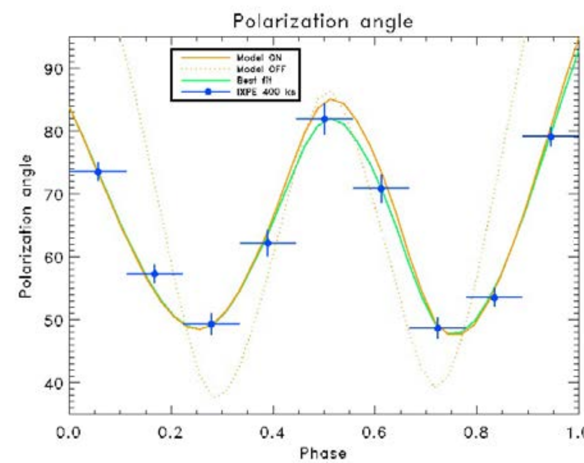
Mit 2 Abbildungen. (Eingegangen am 22. Dezember 1935.)

Aus der Diracschen Theorie des Positrons folgt, da jedes elektromagnetische Feld zur Paarerzeugung neigt, eine Abänderung der Maxwellschen Gleichungen des Vakuums. Diese Abänderungen werden für den speziellen Fall berechnet, in dem keine wirklichen Elektronen und Positronen vorhanden sind, und in dem sich das Feld auf Strecken der Compton-Wellenlänge nur wenig ändert. Es ergibt sich für das Feld eine Lagrange-Funktion:

**Weisskopf, V.C. (1936)**
**Uber die Elektrodynamik des Vakuums auf Grund der Quanten-theorie des Elektrons. Det Kgl Danske Viden Selskab Mat fys Medd XIV 6:1–36**

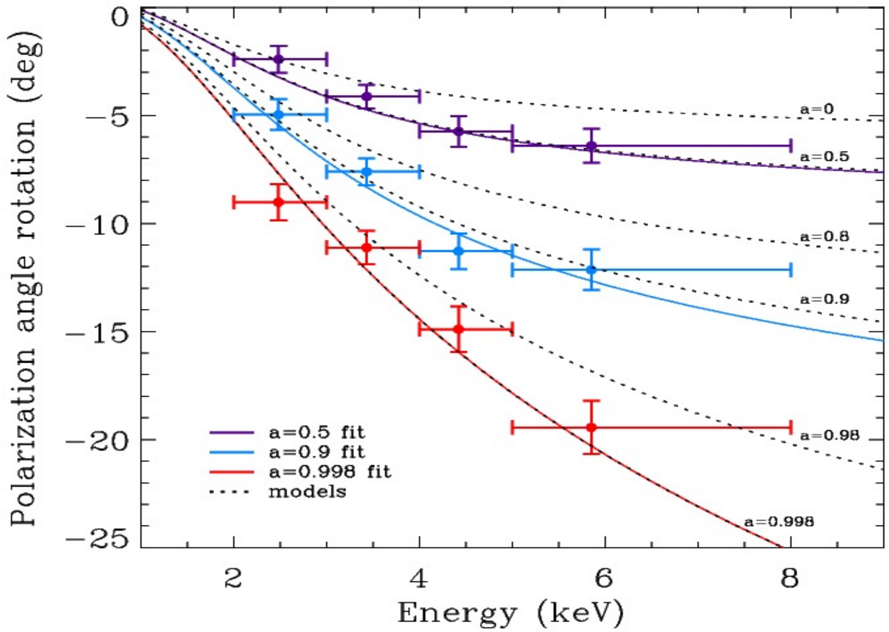
- Magnetars are pulsing neutron stars with magnetic fields up to $10^{15}$ Gauss
- Non-linear QED predicts magnetized-vacuum birefringence
- An effect predicted more than 80 years ago but never verified



# Microquasars: Measuring The Spin of a Black Hole

**Rotation of the polarization angle with energy**




**200 ks IXPE observation of GRS1915+105**