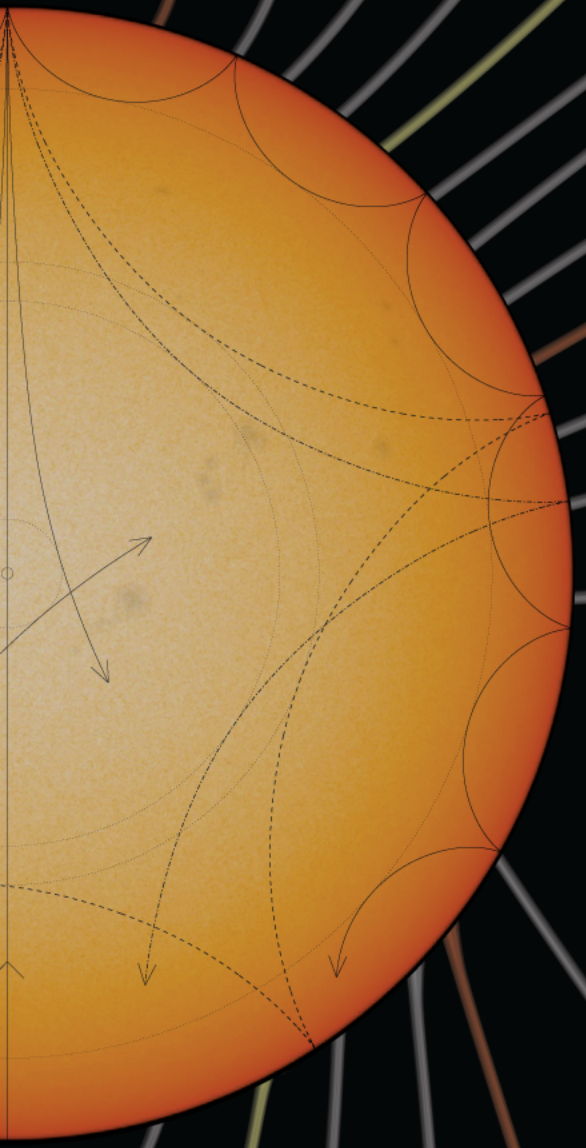


ACTIVE AND EPHEMERAL REGIONS IN THE SOLAR MEAN MAGNETIC FIELD

EDDIE ROSS

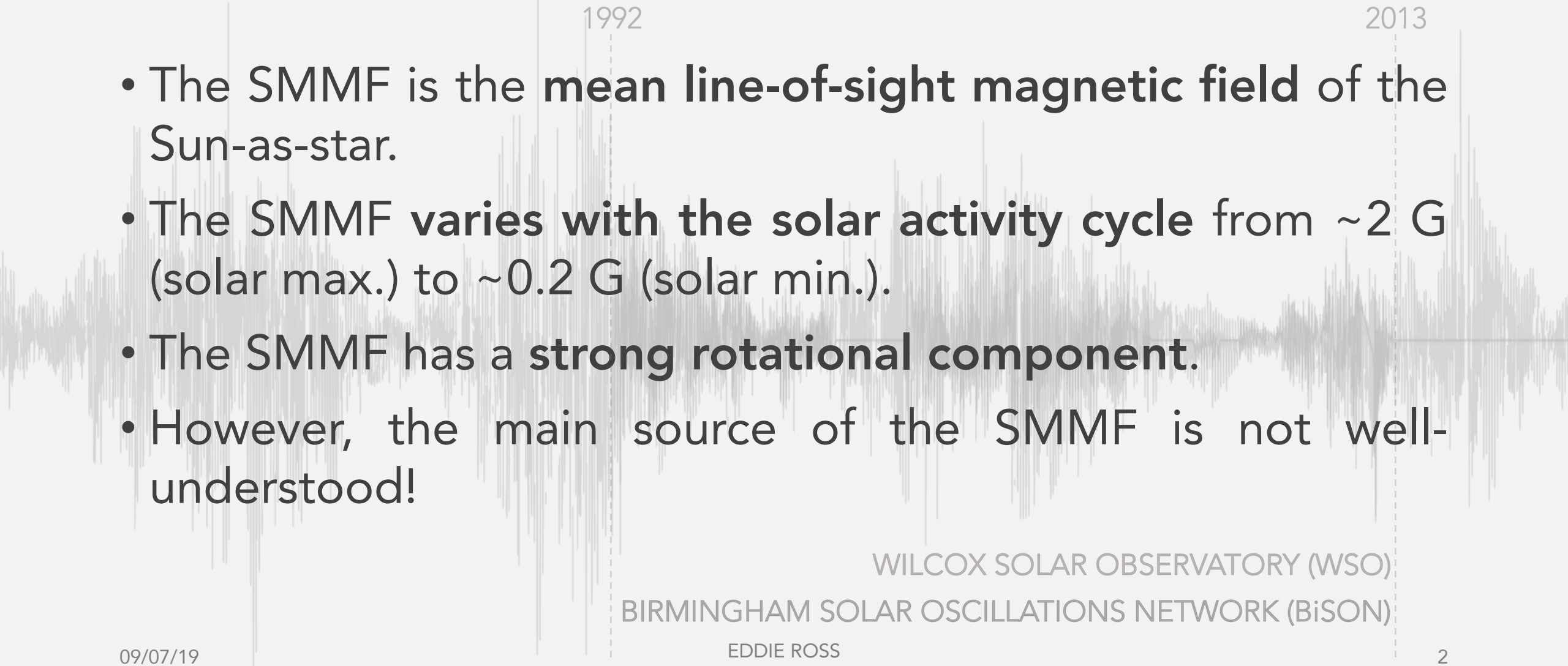
W.J. CHAPLIN, G.R. DAVIES, Y.P. ELSWORTH, S.J. HALE, R. HOWE

UNIVERSITY OF BIRMINGHAM | SCHOOL OF PHYSICS AND ASTRONOMY

EDDIE ROSS

SUN, STARS, AND EXOPLANETS

SOLAR MEAN MAGNETIC FIELD (SMMF)

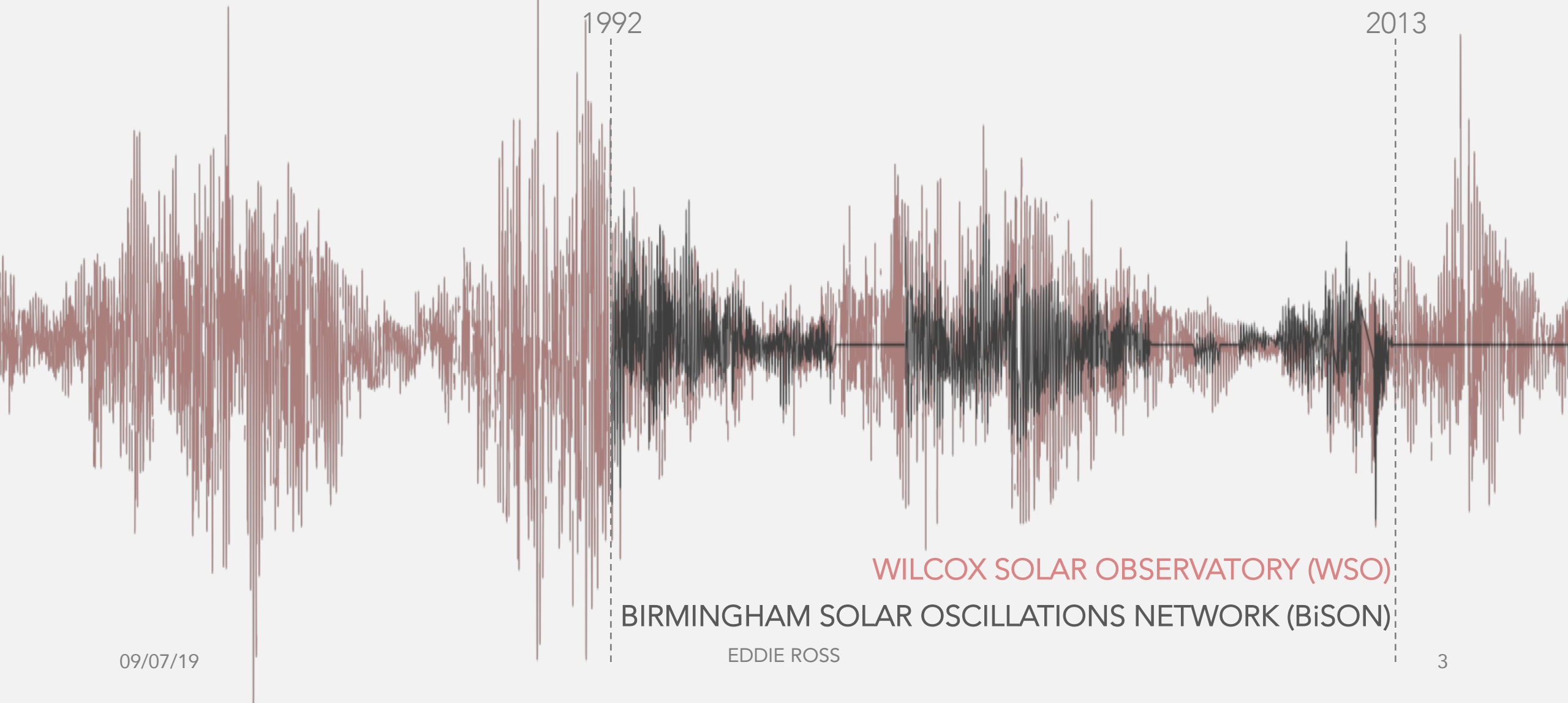


- The SMMF is the **mean line-of-sight magnetic field** of the Sun-as-star.
- The SMMF **varies with the solar activity cycle** from ~2 G (solar max.) to ~0.2 G (solar min.).
- The SMMF has a **strong rotational component**.
- However, the main source of the SMMF is not well-understood!

WILCOX SOLAR OBSERVATORY (WSO)

BIRMINGHAM SOLAR OSCILLATIONS NETWORK (BiSON)

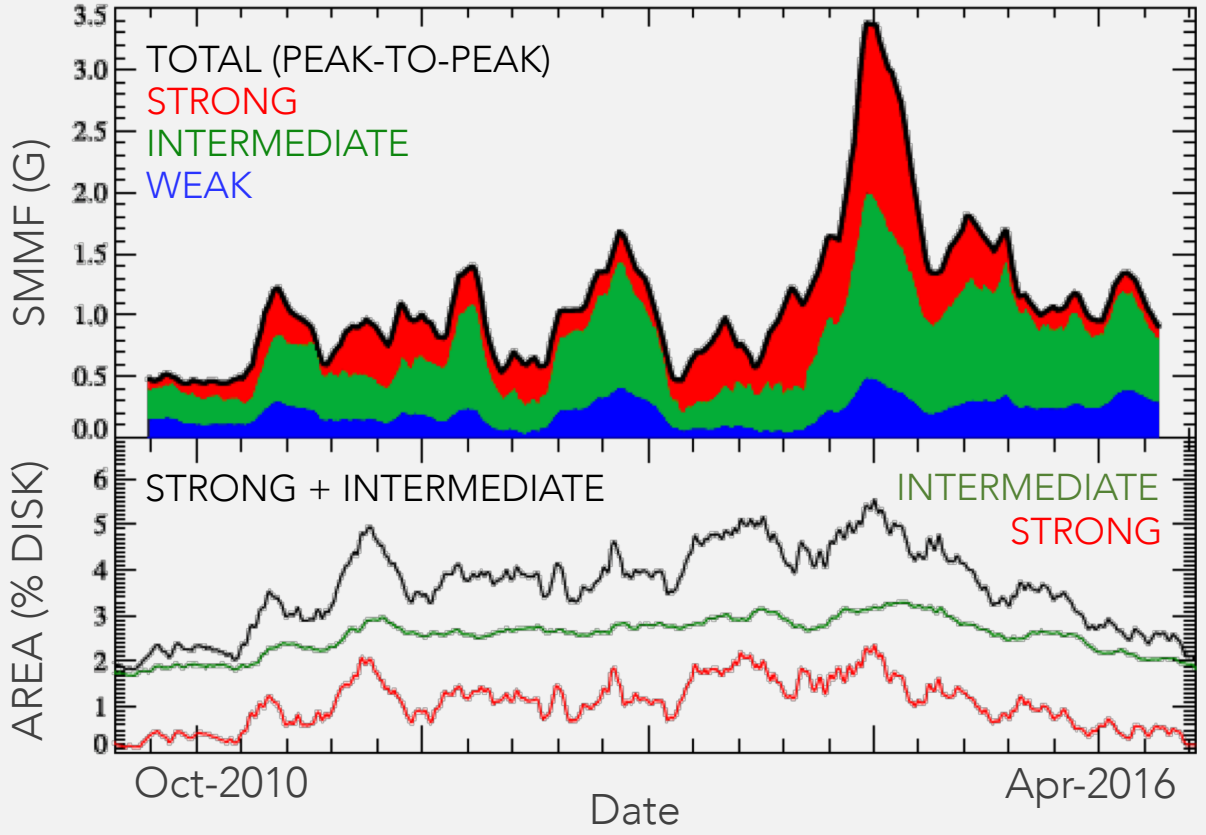
SOLAR MEAN MAGNETIC FIELD (SMMF)



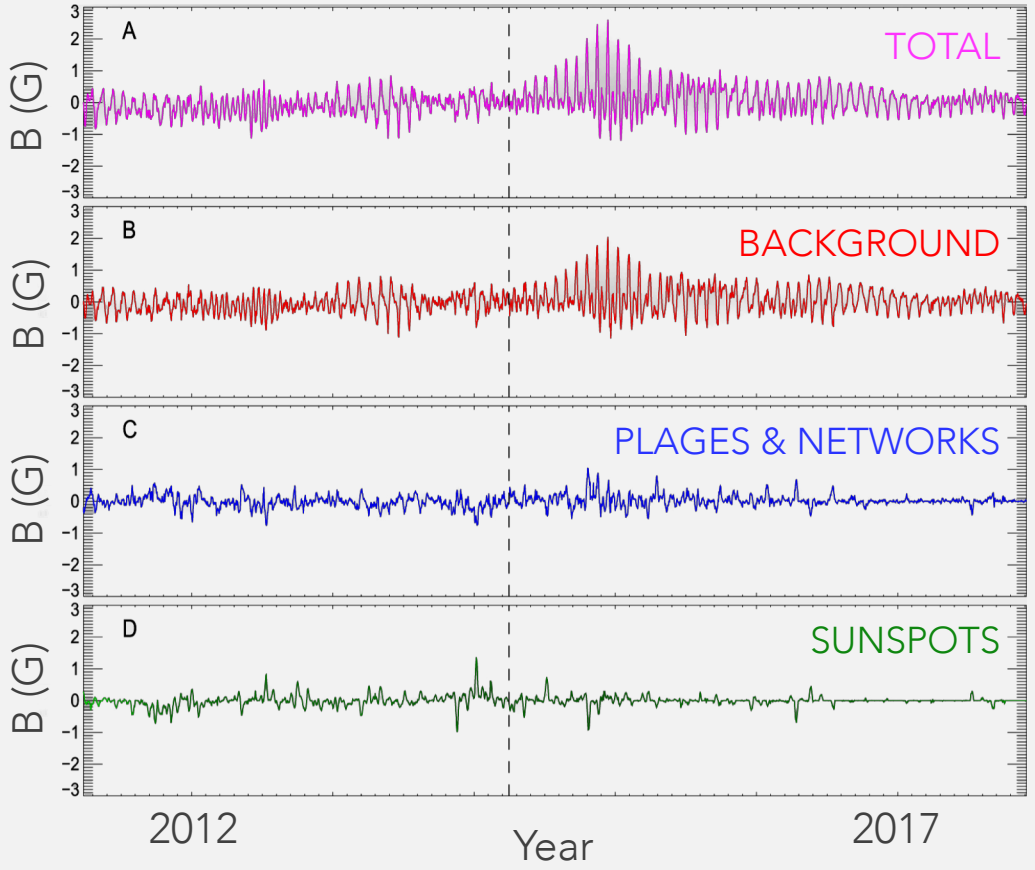
WILCOX SOLAR OBSERVATORY (WSO)

BIRMINGHAM SOLAR OSCILLATIONS NETWORK (BiSON)

SOLAR MEAN MAGNETIC FIELD (SMMF)

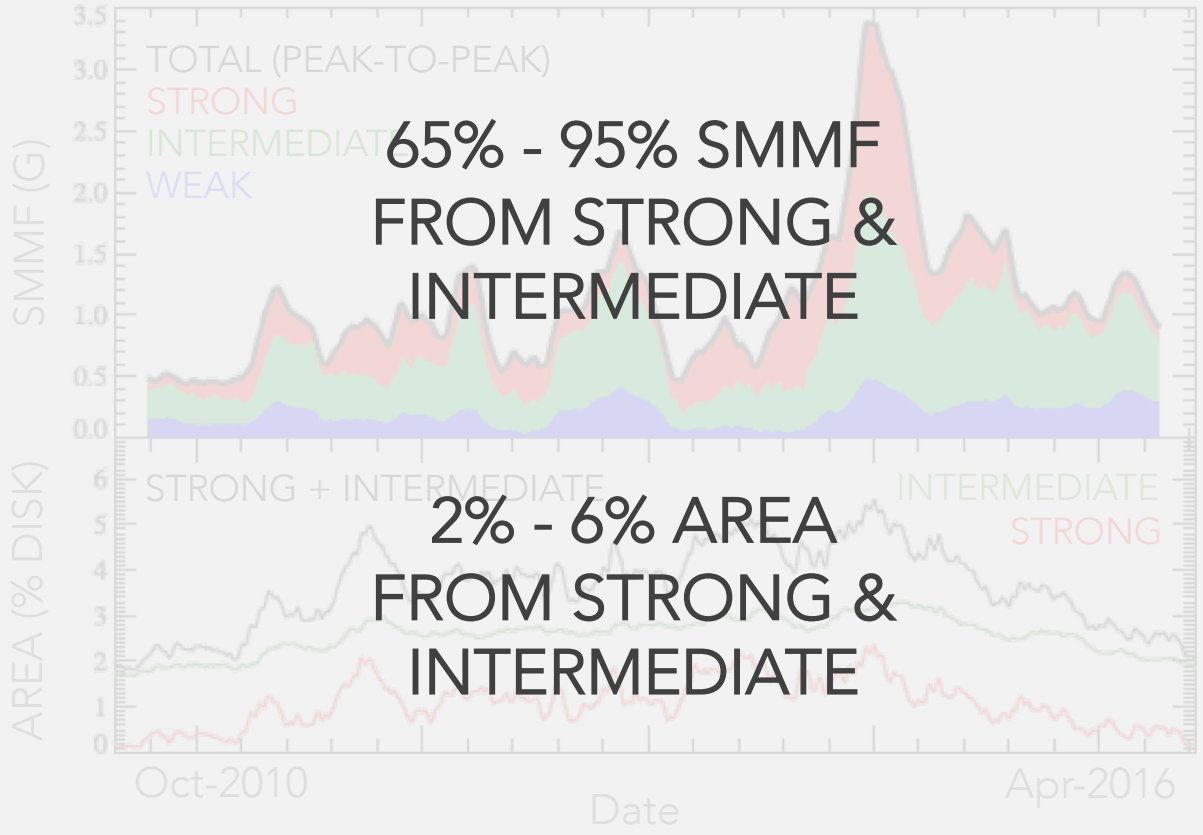


Kutsenko et al. (2017) *Solar Phys.*

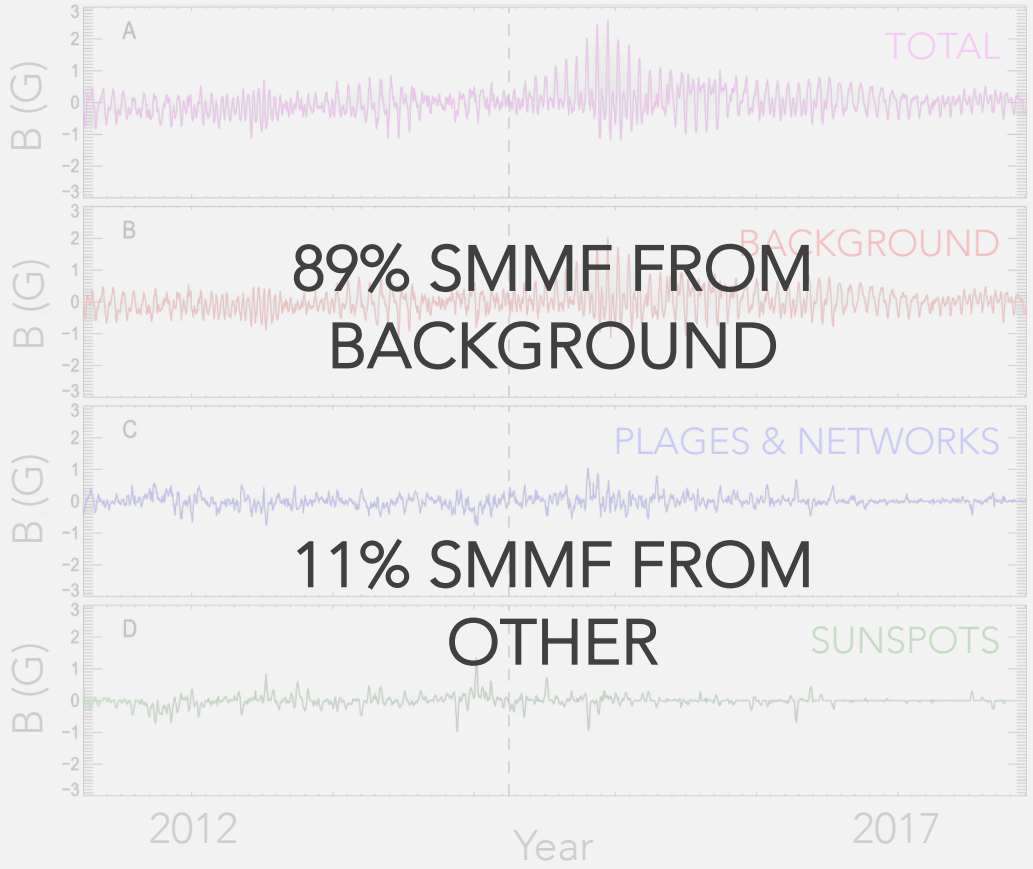


Bose and Nagaraju (2018) *ApJ*

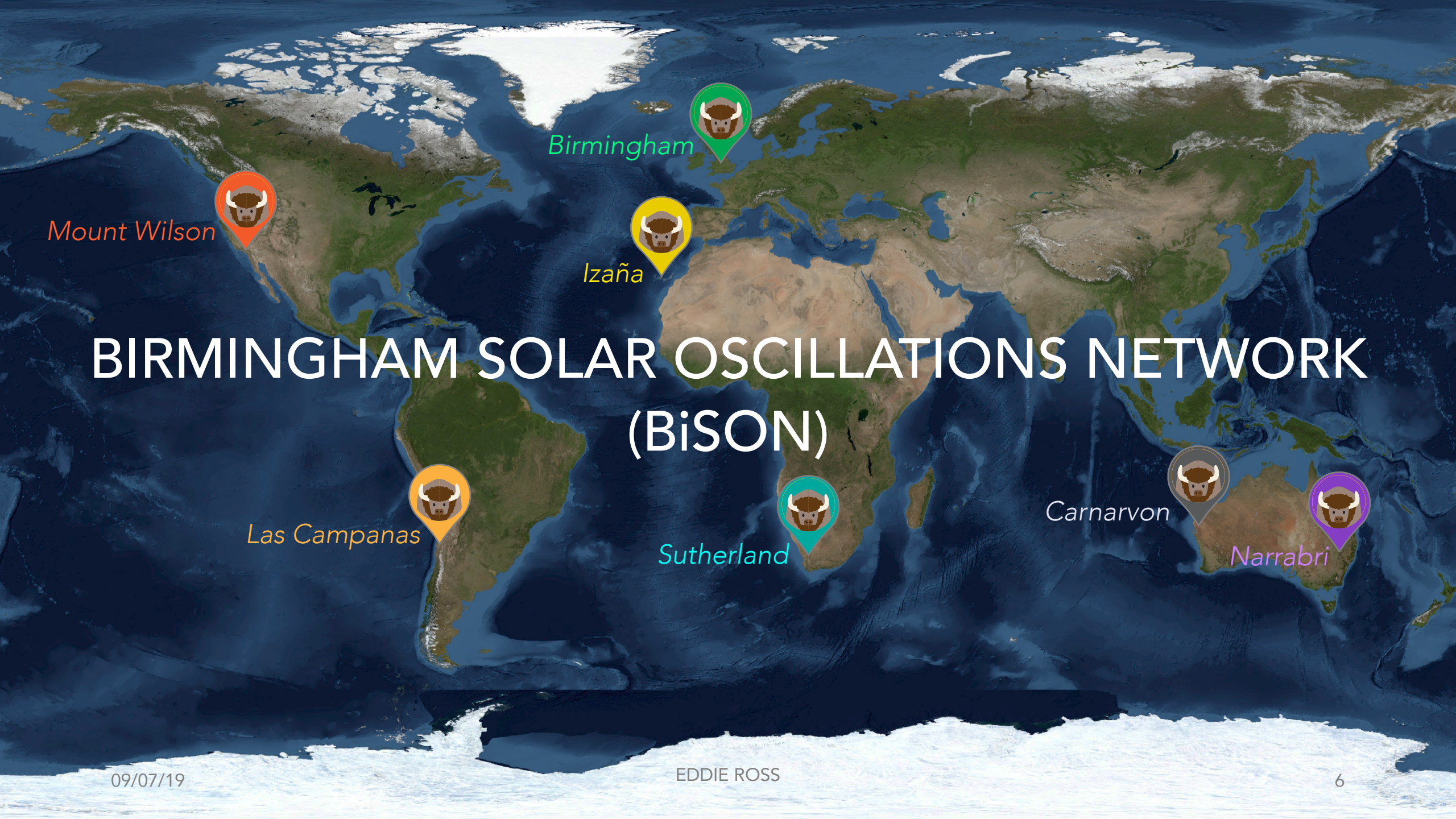
SOLAR MEAN MAGNETIC FIELD (SMMF)



Kutsenko et al. (2017) *Solar Phys.*



Bose and Nagaraju (2018) *ApJ*


Birmingham
Mount Wilson
Izaña
BIRMINGHAM SOLAR OSCILLATIONS NETWORK (BiSON)
Las Campanas
Sutherland
Carnarvon
Narrabri

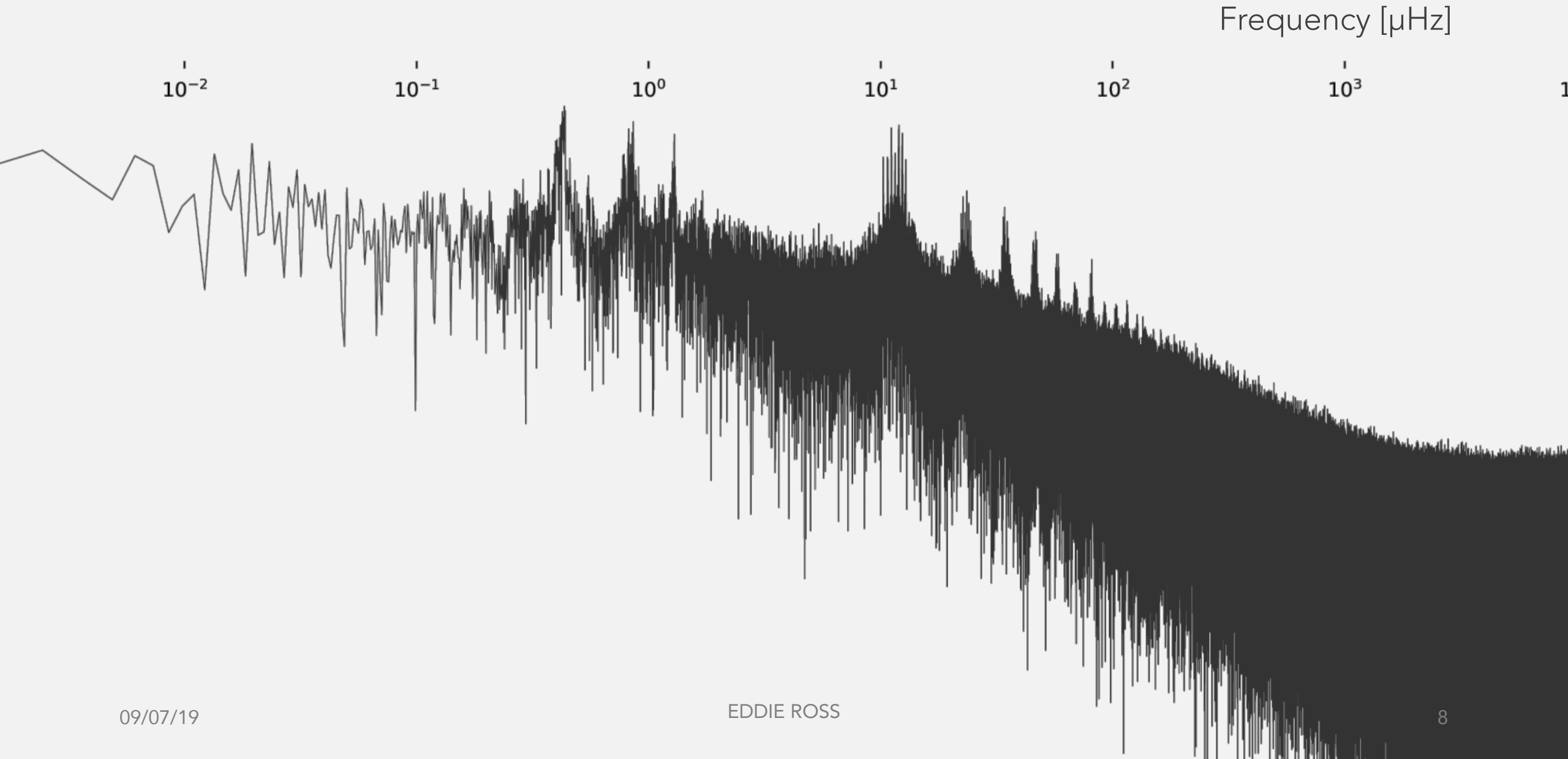
OBJECTIVES

Analyse, for the **first time**, over 20 years of **high-cadence** (40-second) observations of the **SMMF** from BiSON.

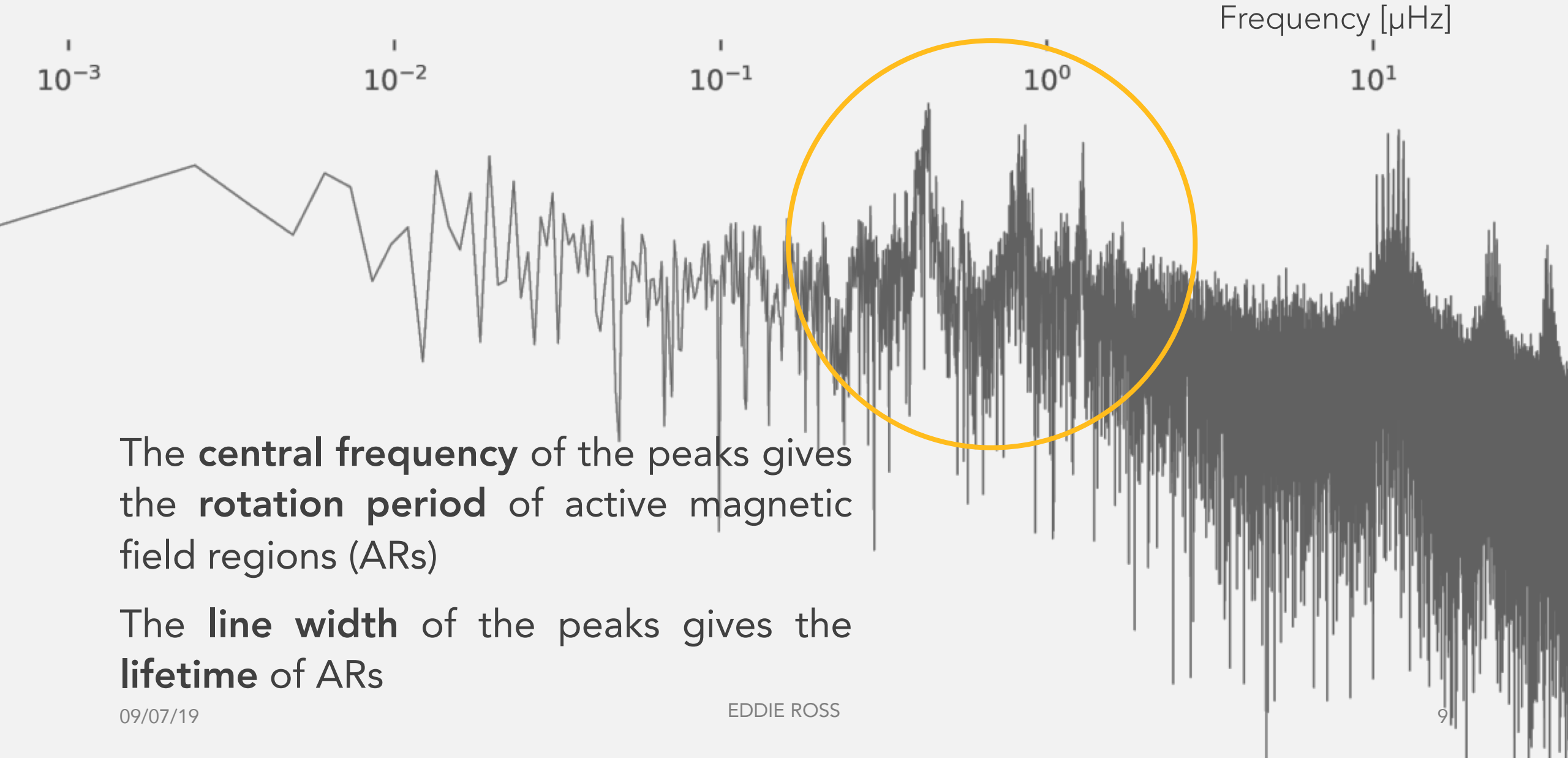
We present an analysis of the SMMF in the **frequency domain** which aimed to:

- Investigate the **rotation** periods
- Investigate the **lifetimes** of features
- Determine the main **source** of the SMMF
- Investigate the solar **cycle variation** of the SMMF background

POWER SPECTRUM (log-log)



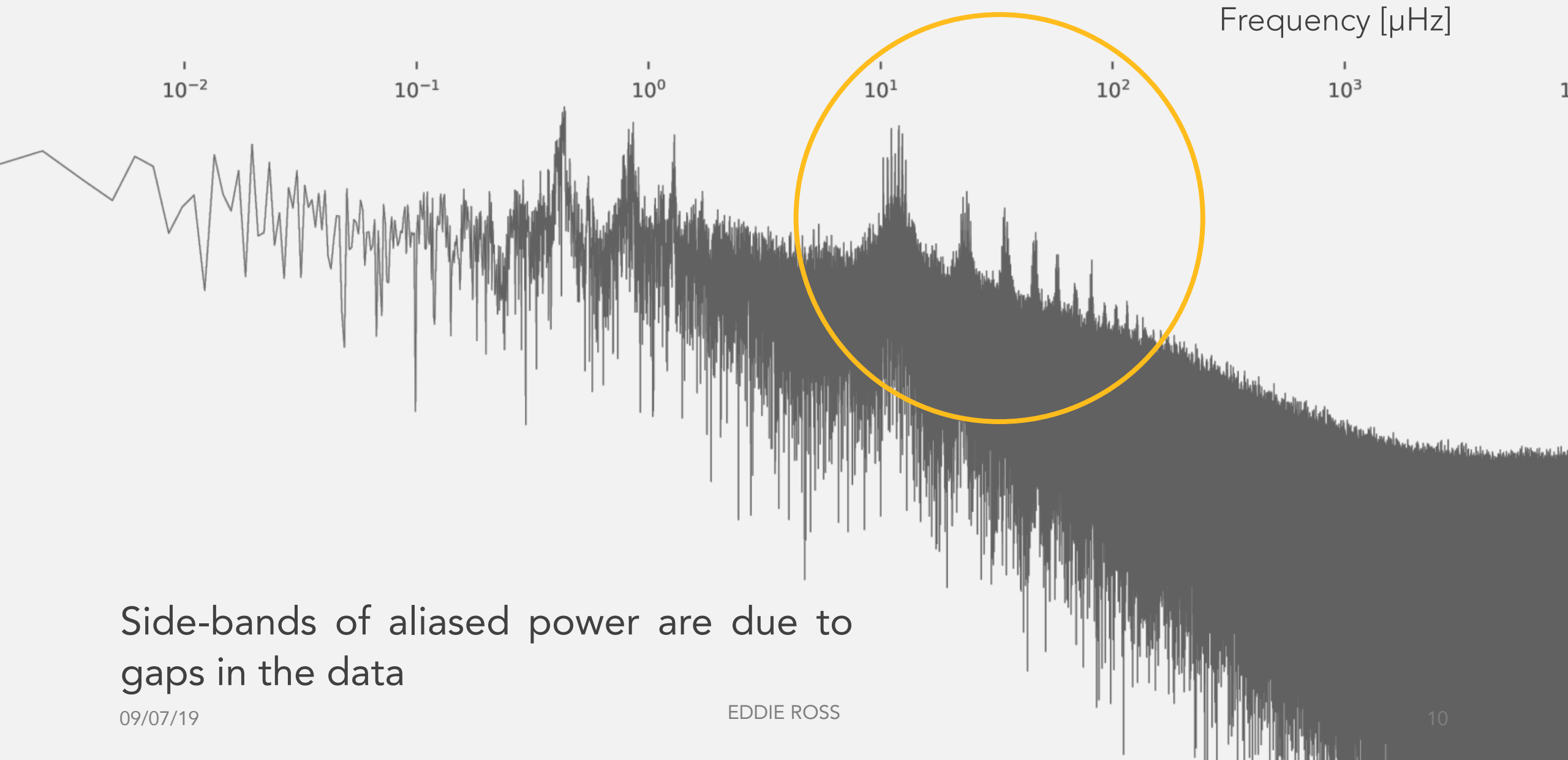
POWER SPECTRUM (log-log)



The **central frequency** of the peaks gives the **rotation period** of active magnetic field regions (ARs)

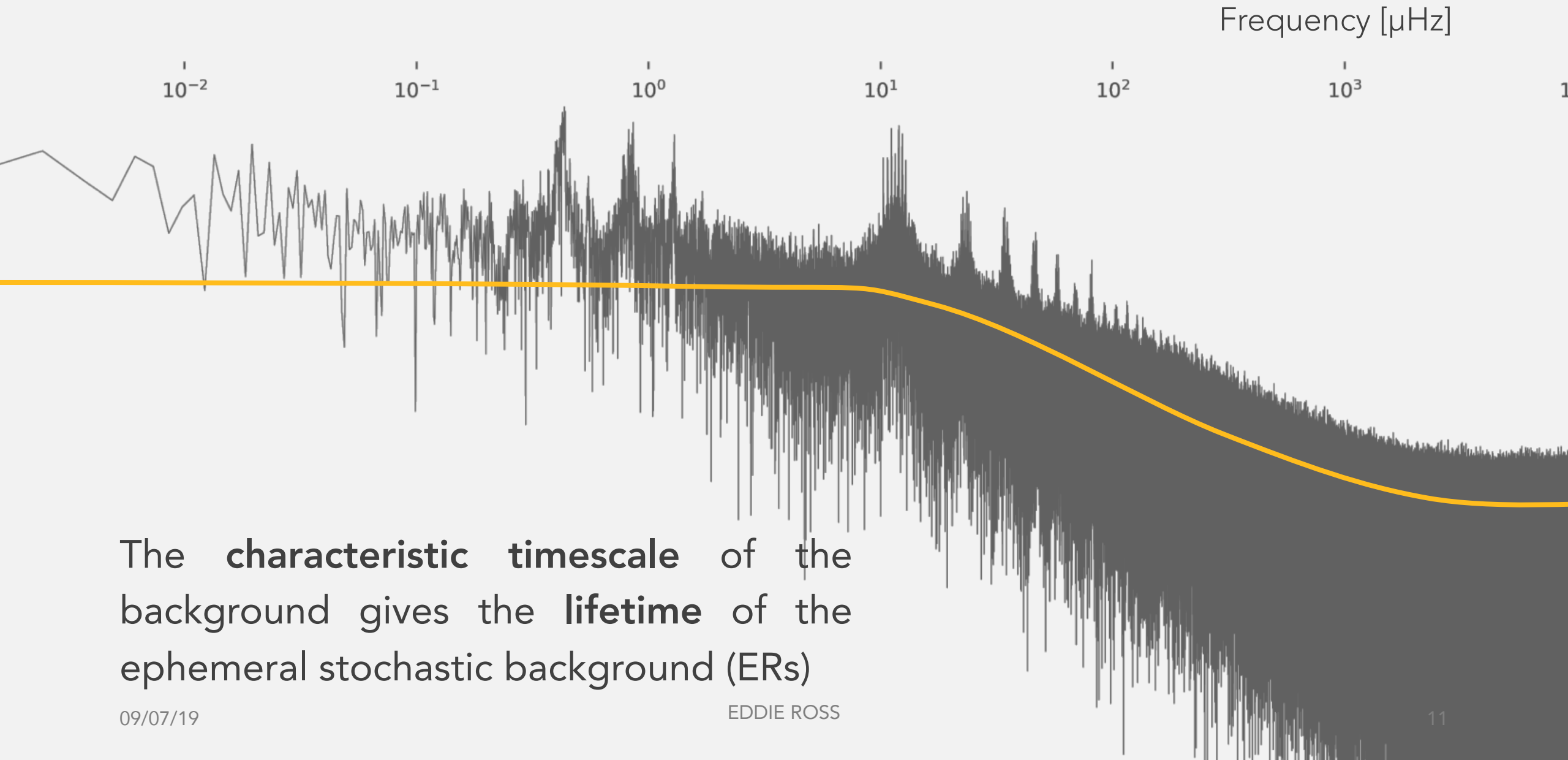
The **line width** of the peaks gives the **lifetime** of ARs

POWER SPECTRUM (log-log)



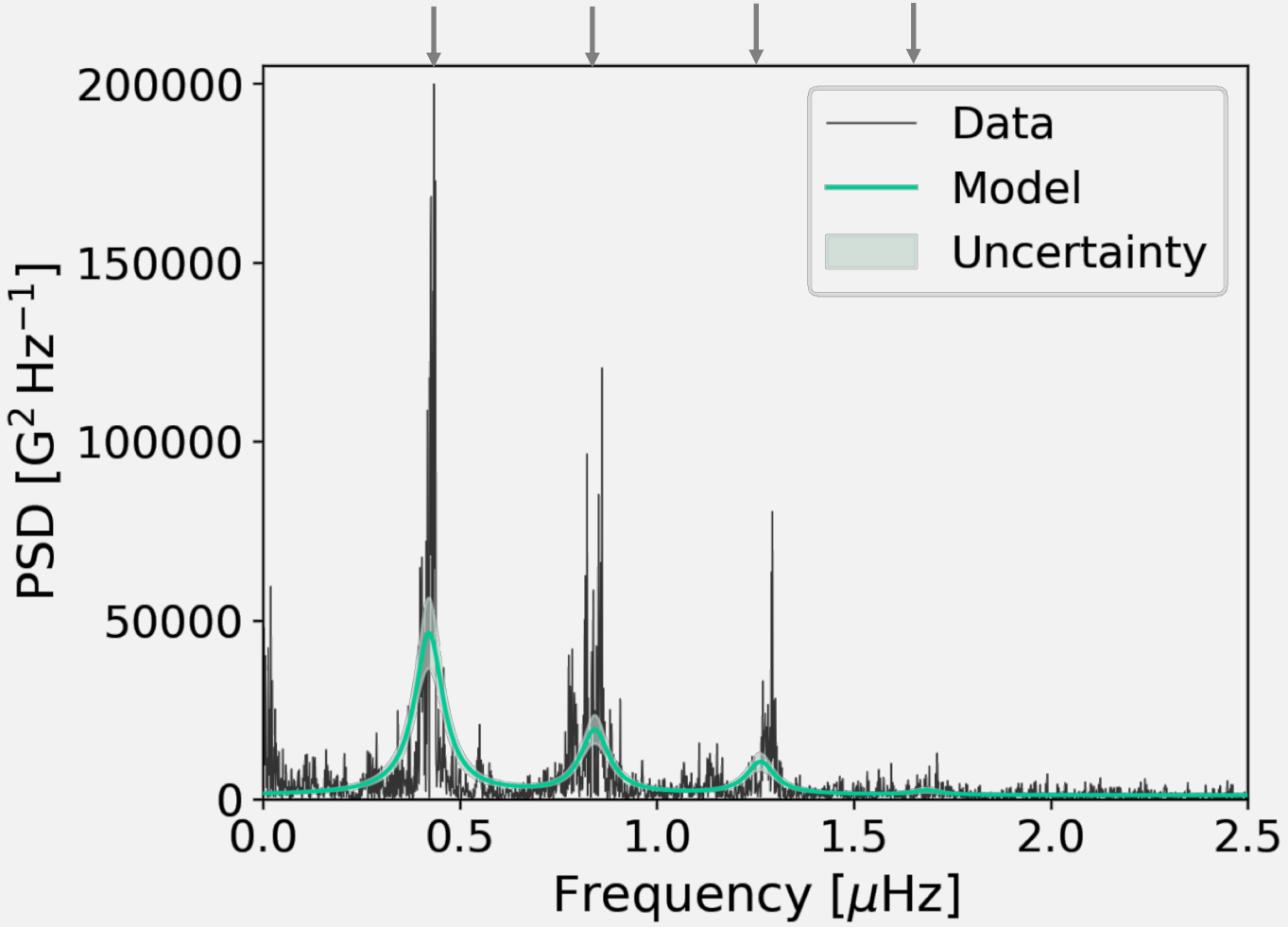
Side-bands of aliased power are due to gaps in the data

POWER SPECTRUM (log-log)



The **characteristic timescale** of the background gives the **lifetime** of the ephemeral stochastic background (ERs)

PRELIM. RESULTS: ROTATION



Synodic rotation:

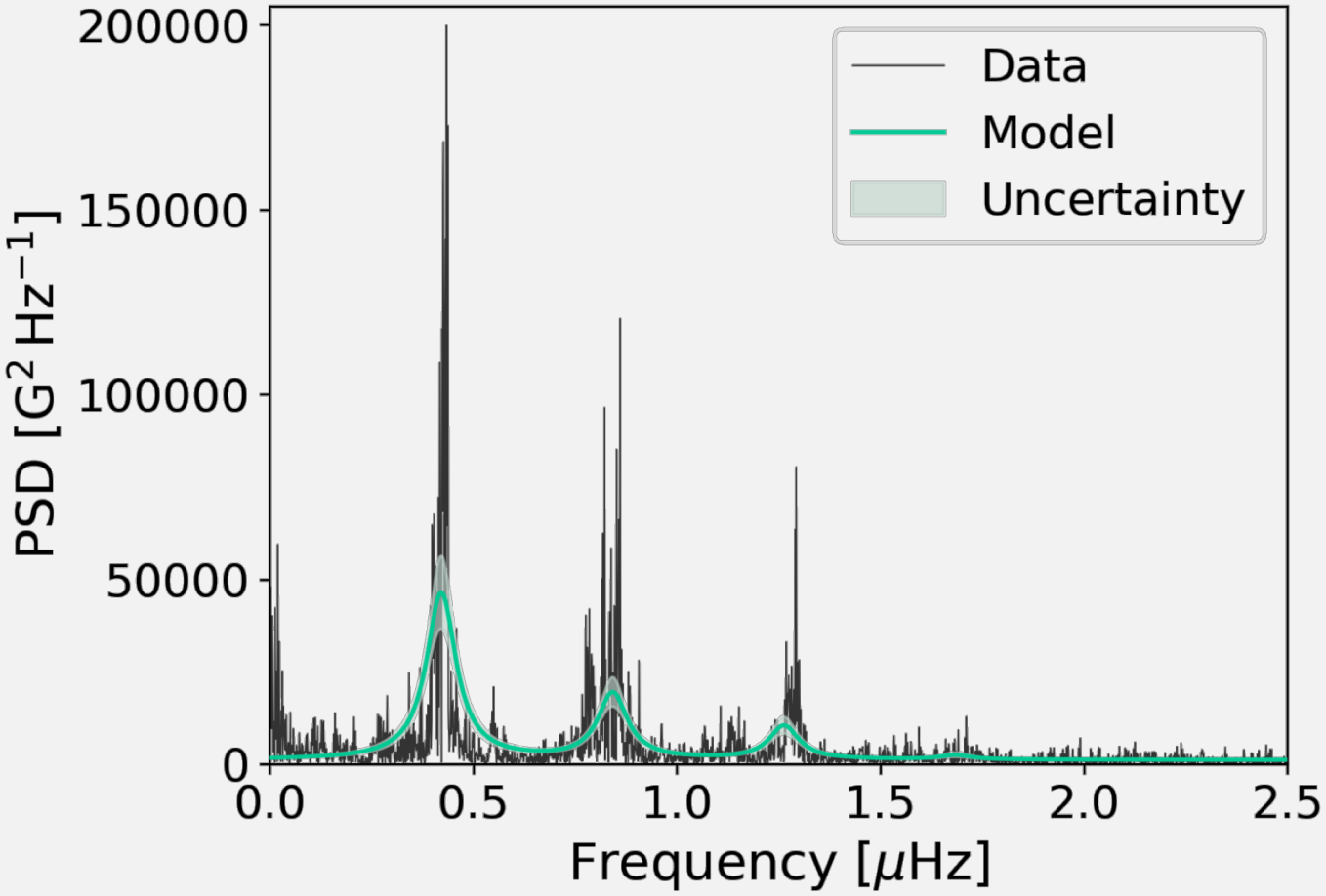
27.49 ± 0.08 days

Sidereal rotation:

25.56 ± 0.07 days

Latitude: $\sim 20^{\circ}$

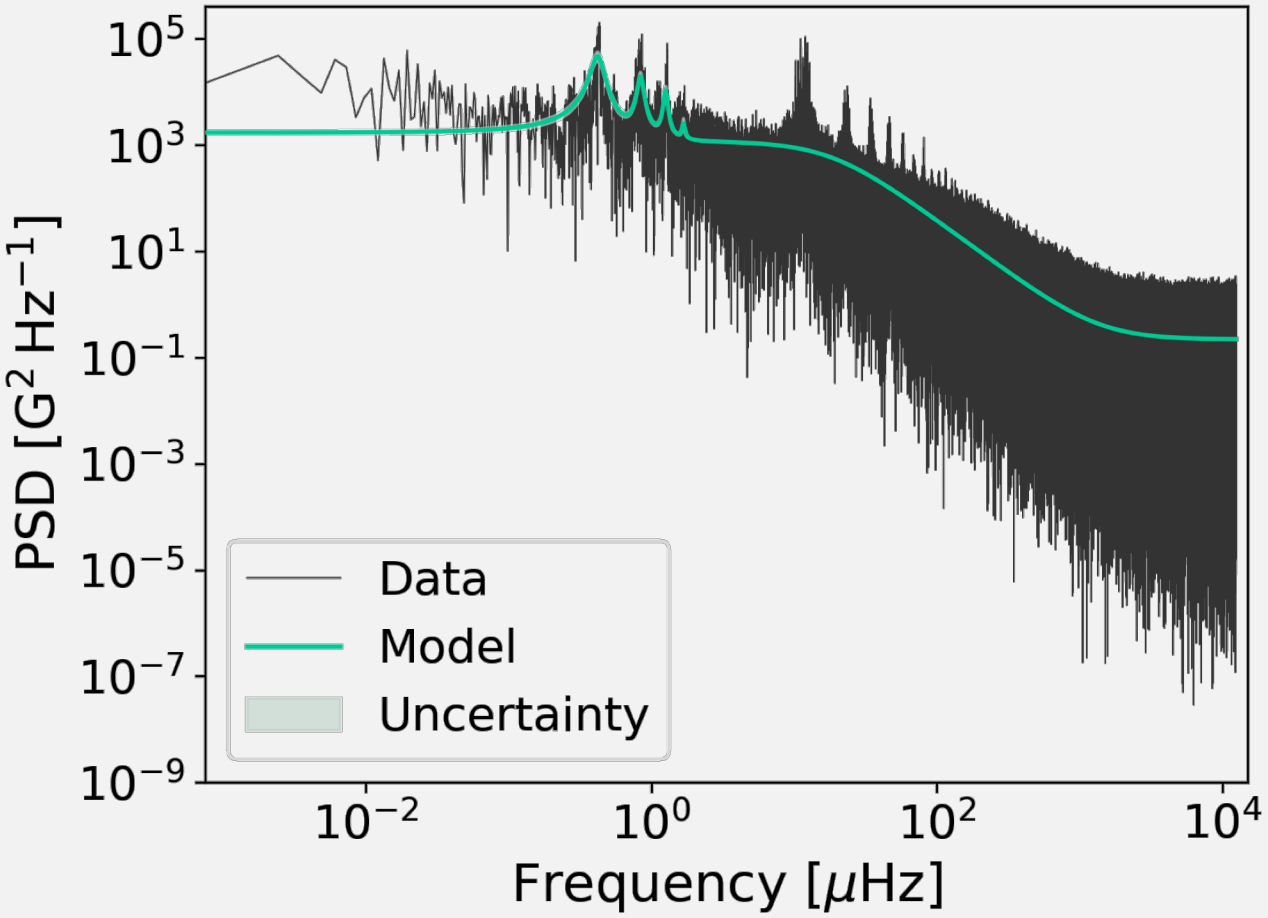
PRELIM. RESULTS: LIFETIMES & COMPOSITION



Lifetime:

ARs: 41.7 ± 3.1 days

PRELIM. RESULTS: LIFETIMES & COMPOSITION



Lifetime:

ARs: 41.7 ± 3.1 days

ERs: 2.41 ± 0.01 hours

Amplitude contribution:

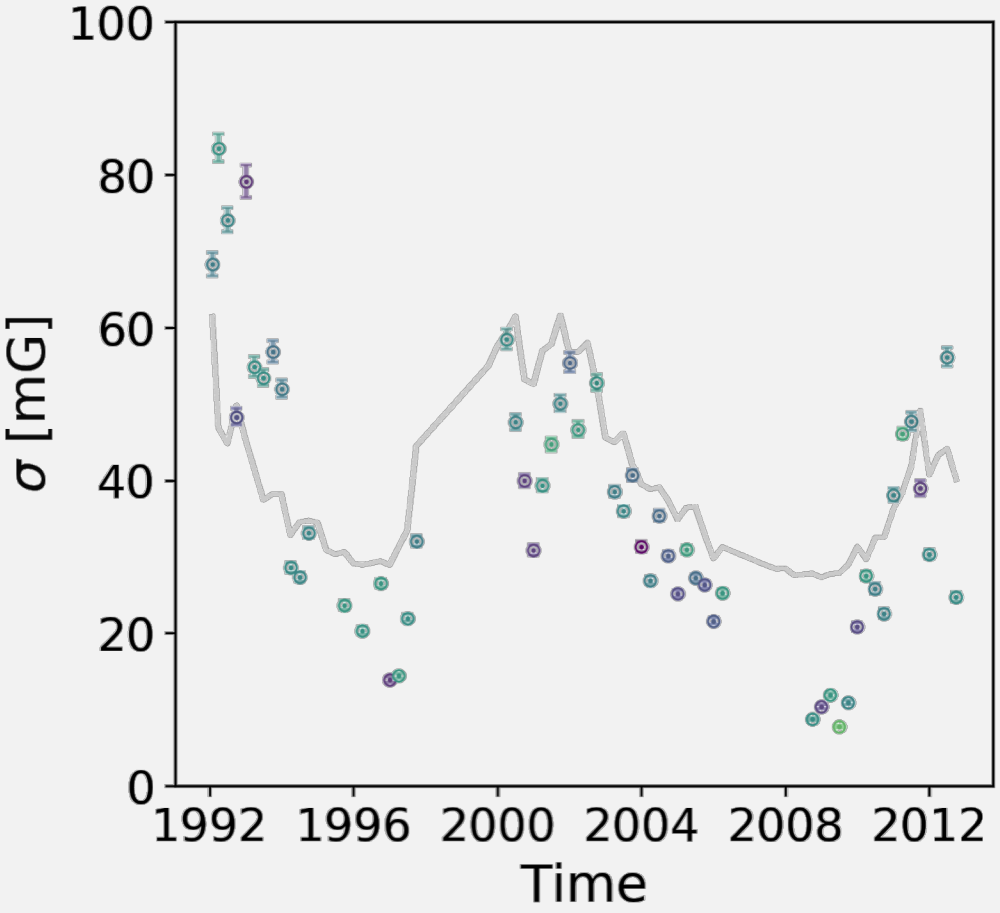
ARs: $\sim 86\ \%$

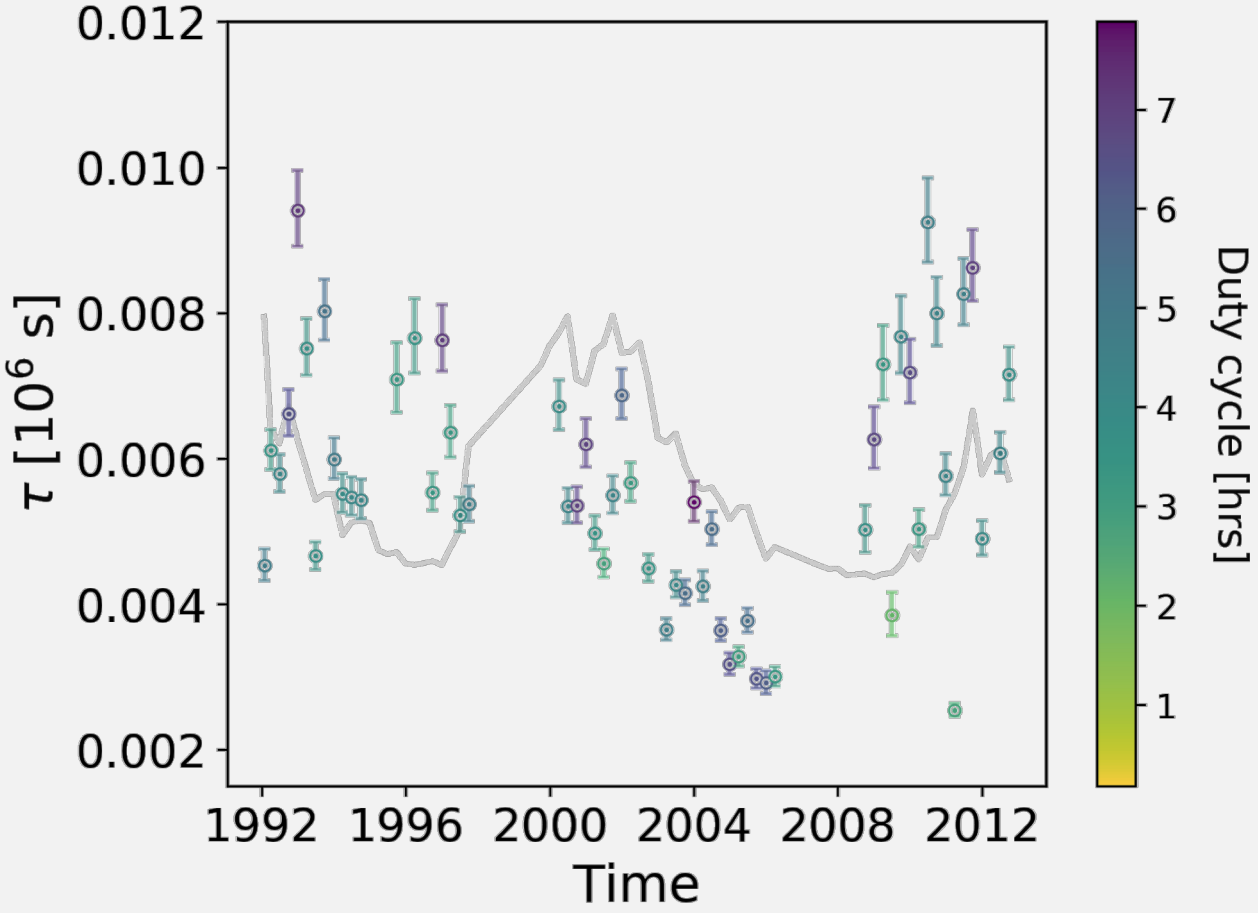
ERs: $\sim 14\ \%$

SOLAR CYCLE VARIATION

- The SMMF was **segmented** into **3-month** intervals.
- In each temporal segment, **matched sinusoids** to the peak frequencies in the power spectra were **removed** from the time-series, **leaving the background** component.
- The background component was then modelled using a zero-centred Lorentzian.

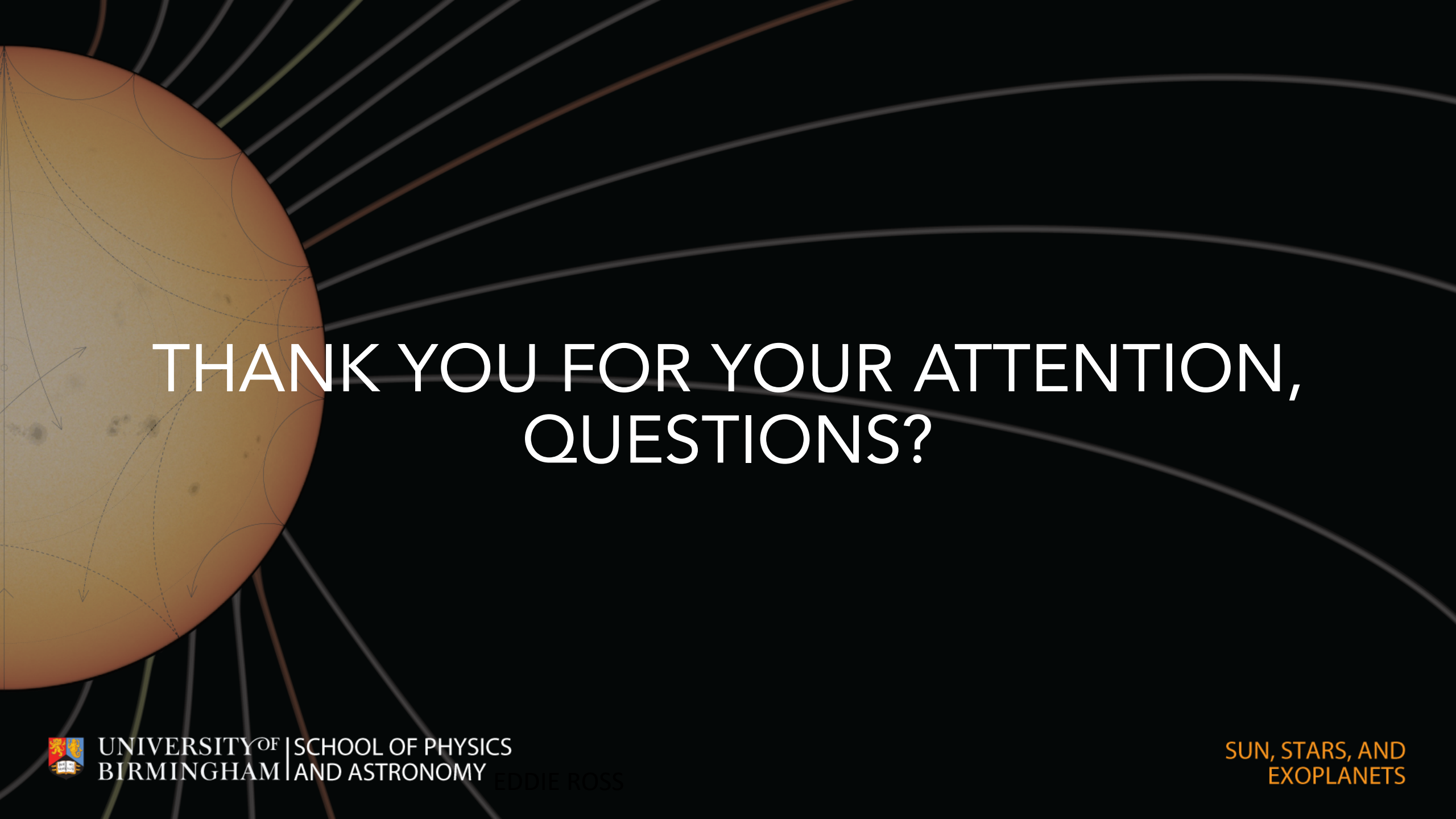
PRELIM. RESULTS: SOLAR CYCLE VARIATION





SUMMARY

- Frequency domain analysis for the **first time** of sub-minute cadence observations of the SMMF.
- Lifetime of ARs: 41.7 ± 3.1 days
- Lifetime of ERs: 2.41 ± 0.01 hours
- **SMMF dominated by ARs**: $\sim 86\,\%$ AR flux / $\sim 14\,\%$ ER flux
- We see **variation** in the RMS amplitude and lifetime of the weak-background field **correlated** to the solar cycle.



THANK YOU FOR YOUR ATTENTION, QUESTIONS?