

## Alien artifacts in astronomical data

*- have we already detected ET?*

Prof. Michael Garrett

General & Scientific Director, ASTRON

Also affiliated with Leiden Observatory.

## ● **Artifact SETI**

Signatures of advanced civilizations in astronomical data:

- some potential examples e.g. KIC 8462852,
- as instruments improve, detection becomes more likely,
- are ET signatures already present as artifacts in our data?

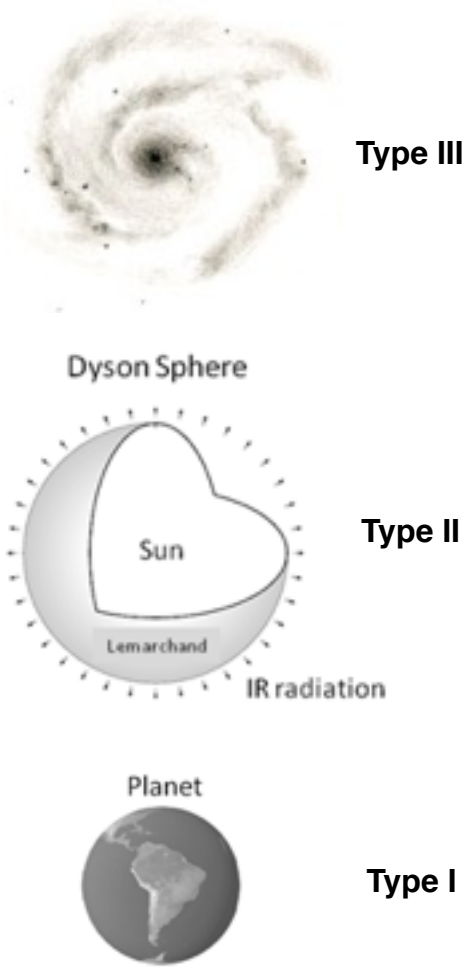
## ● **SETI with ALMA**

ALMA is a fantastic new sub-mm radio telescope:

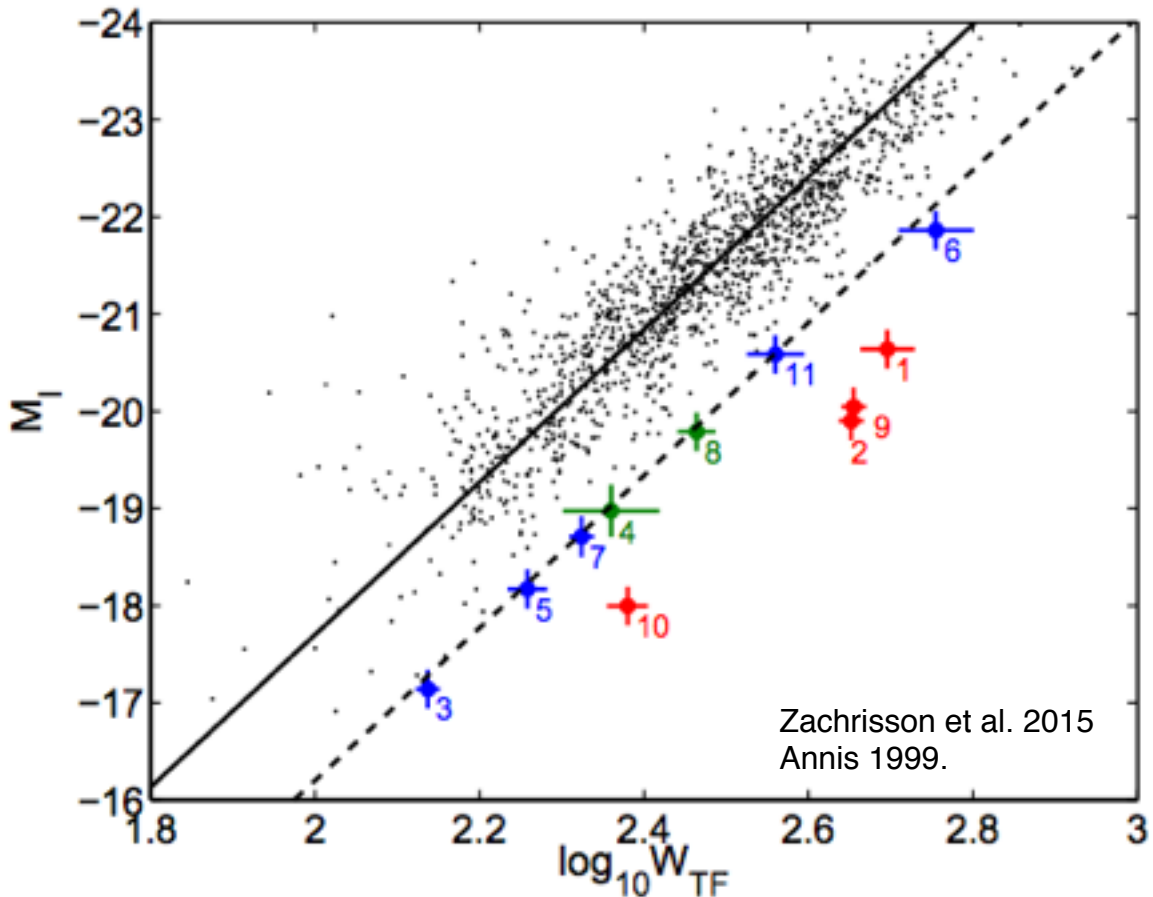
- communication SETI at THz frequencies,
- waste heat emission from energy efficient civilizations.

# Artifact SETI

Effects of advanced civilizations (or civilizations with heavy energy demands) will be easiest to detect e.g. Kardashev Type III/II:



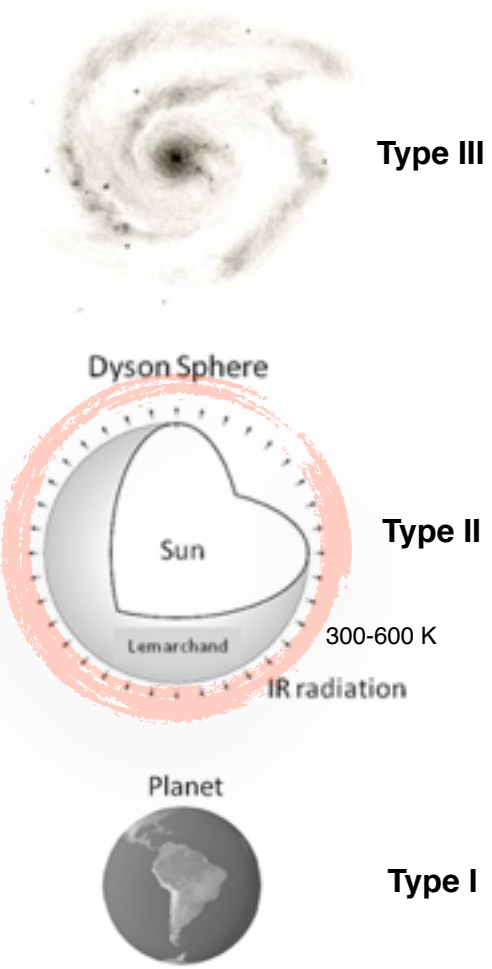
Looking for outliers in well known galaxy scaling laws e.g. Tully-Fisher:



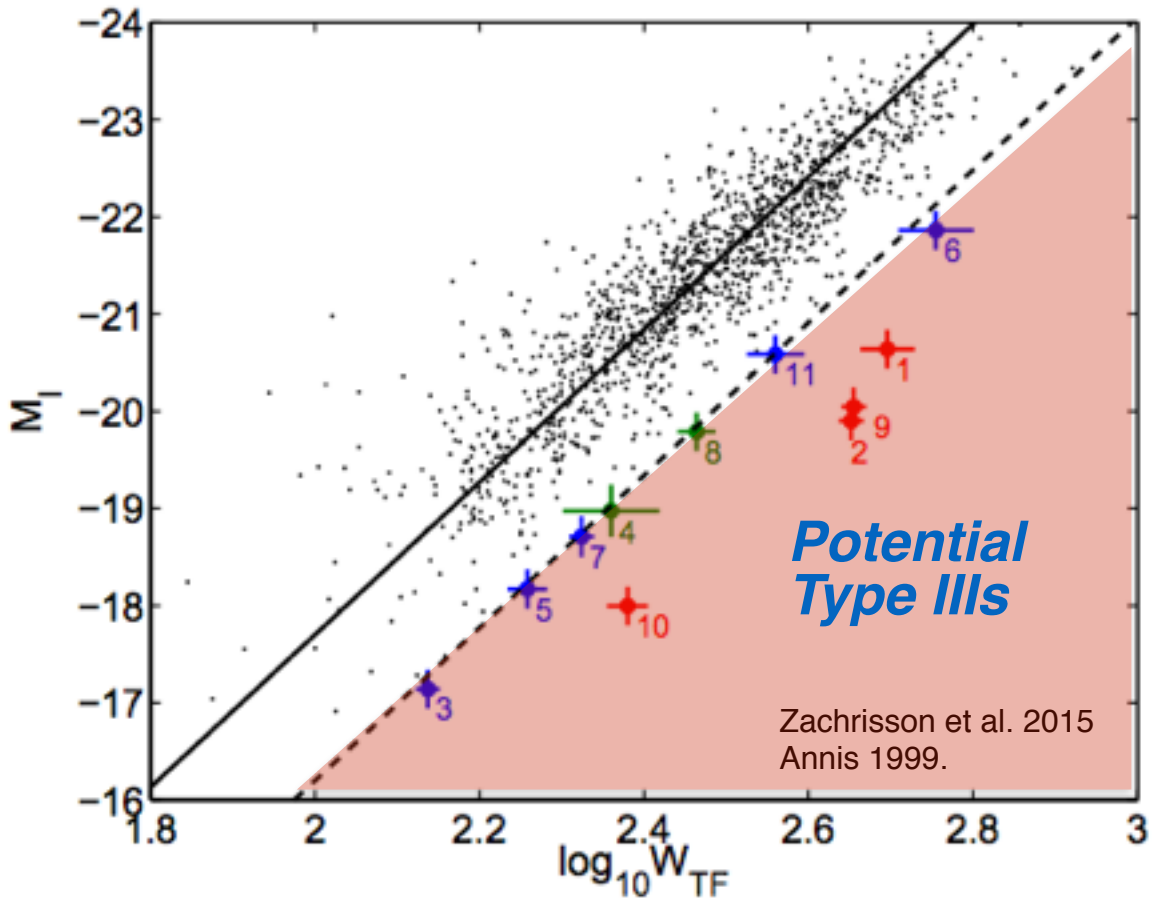
Zachrisson et al. 2015  
Annis 1999.

# Artifact SETI

Effects of advanced civilizations (or civilizations with heavy energy demands) will be easiest to detect e.g. Kardashev Type III/II:



Looking for outliers in well known galaxy scaling laws e.g. Tully-Fisher:

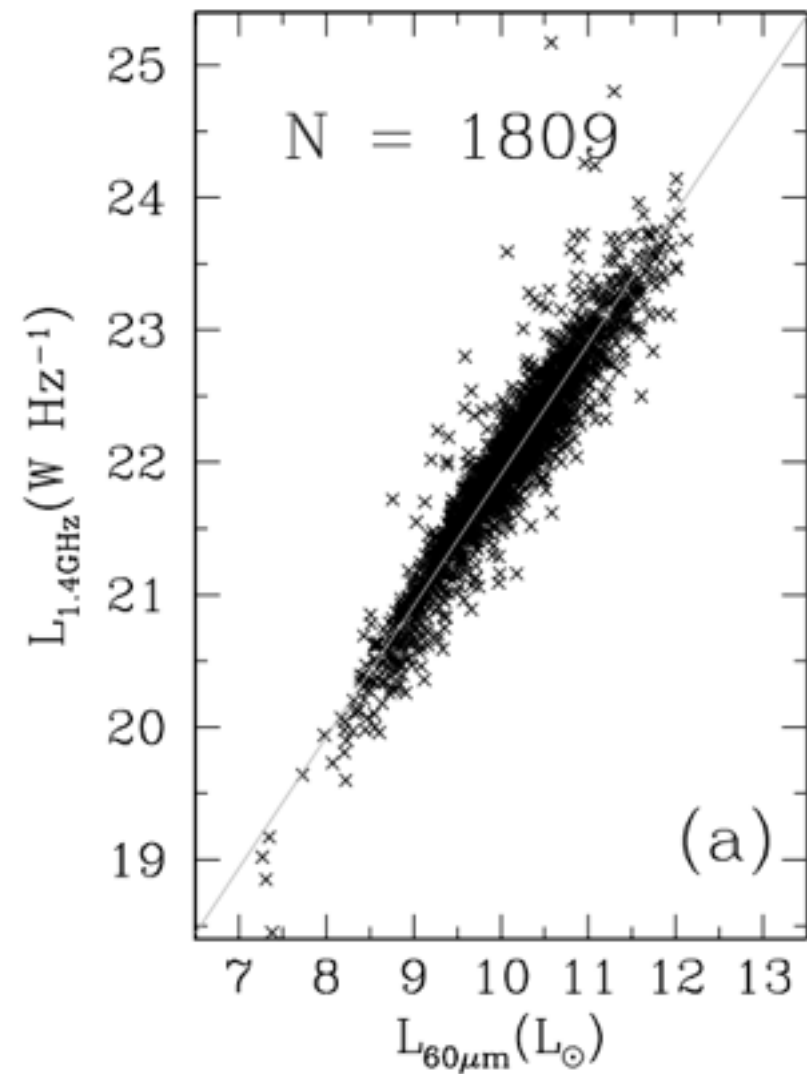


Kardashev 1964

Zachrisson et al. 2015  
Annis 1999.

# Another global scaling law for galaxies:

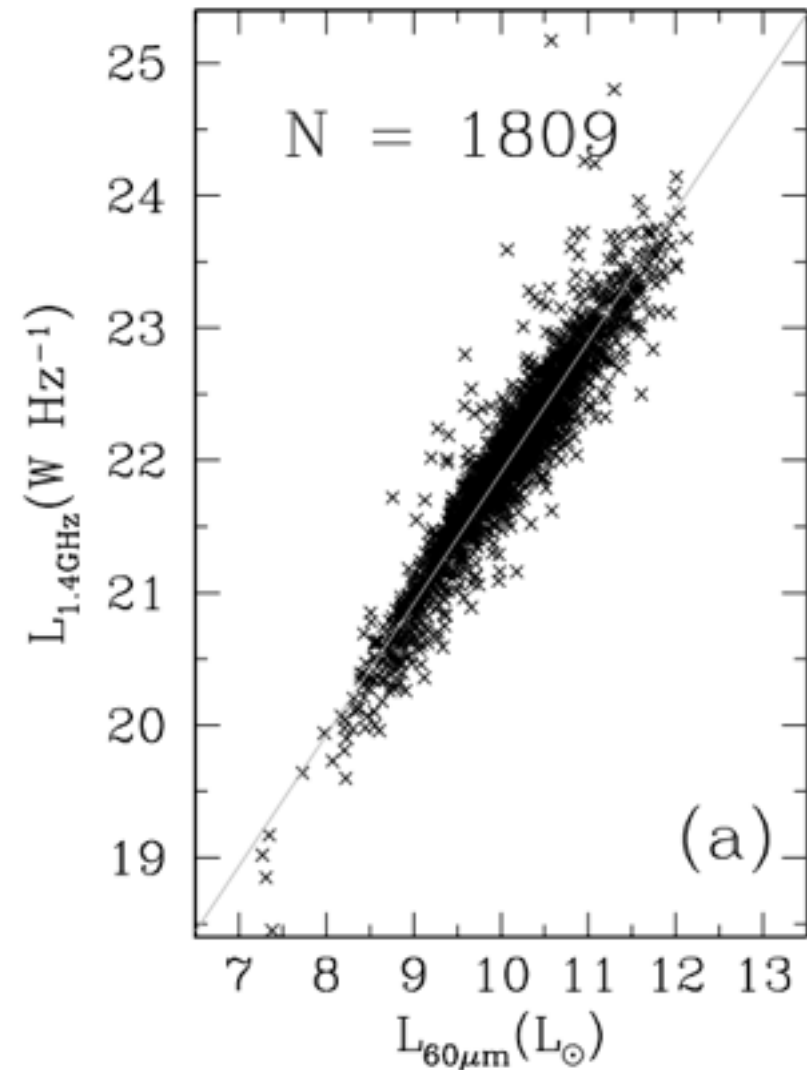
van der Kruit 1970, Yun, Carilli & Condon 2001



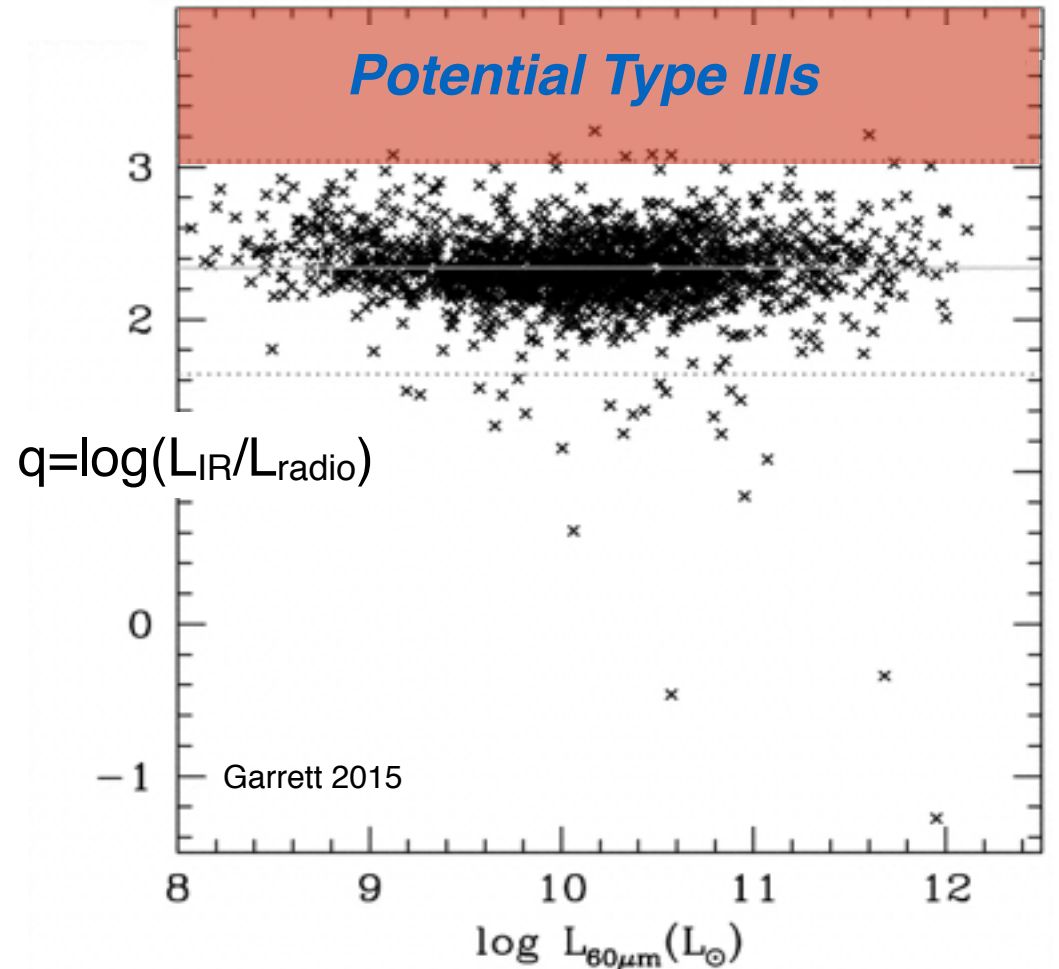


# Another global scaling law for galaxies:

Yun, Carilli & Condon 2001



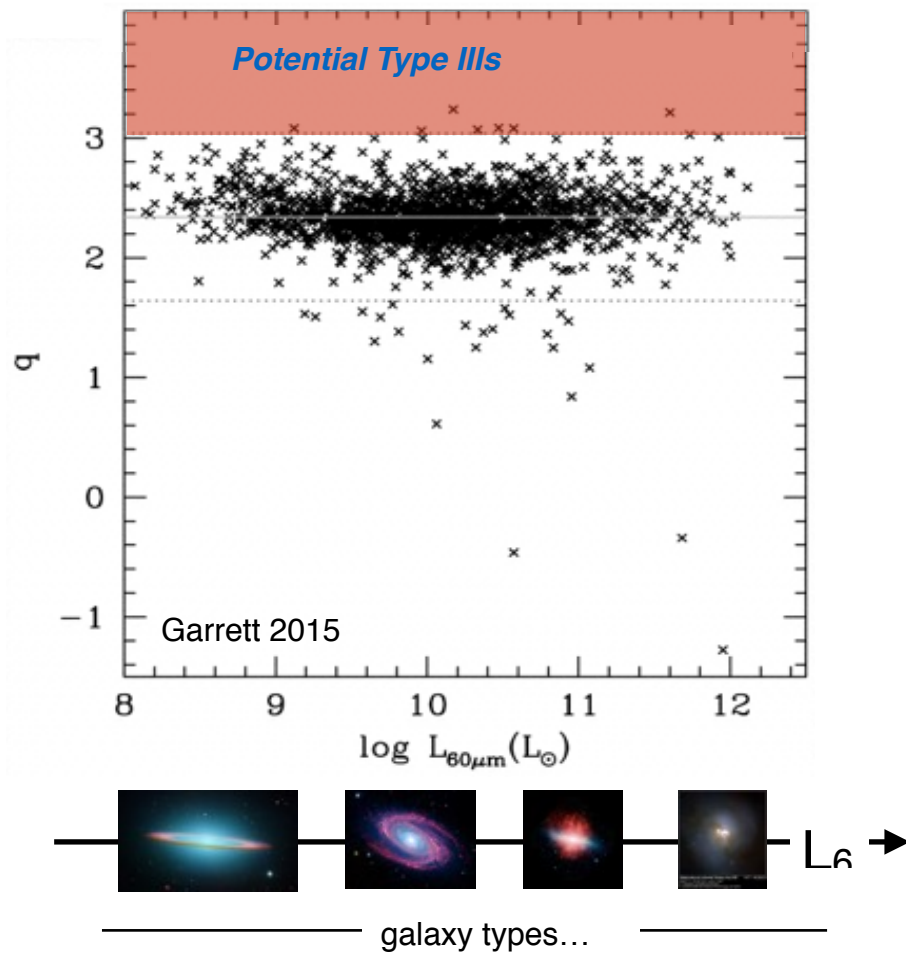
Again outliers are interesting...



Different galaxy types...

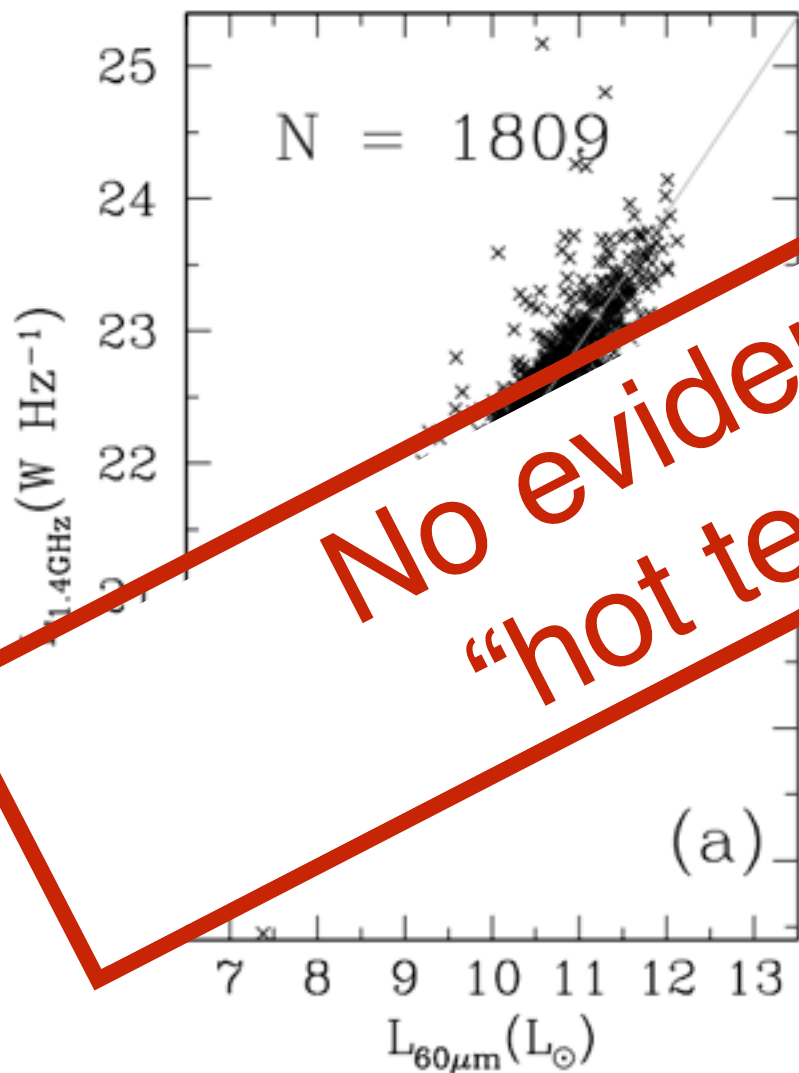
# Why outliers are interesting...

First and second laws of thermodynamics...

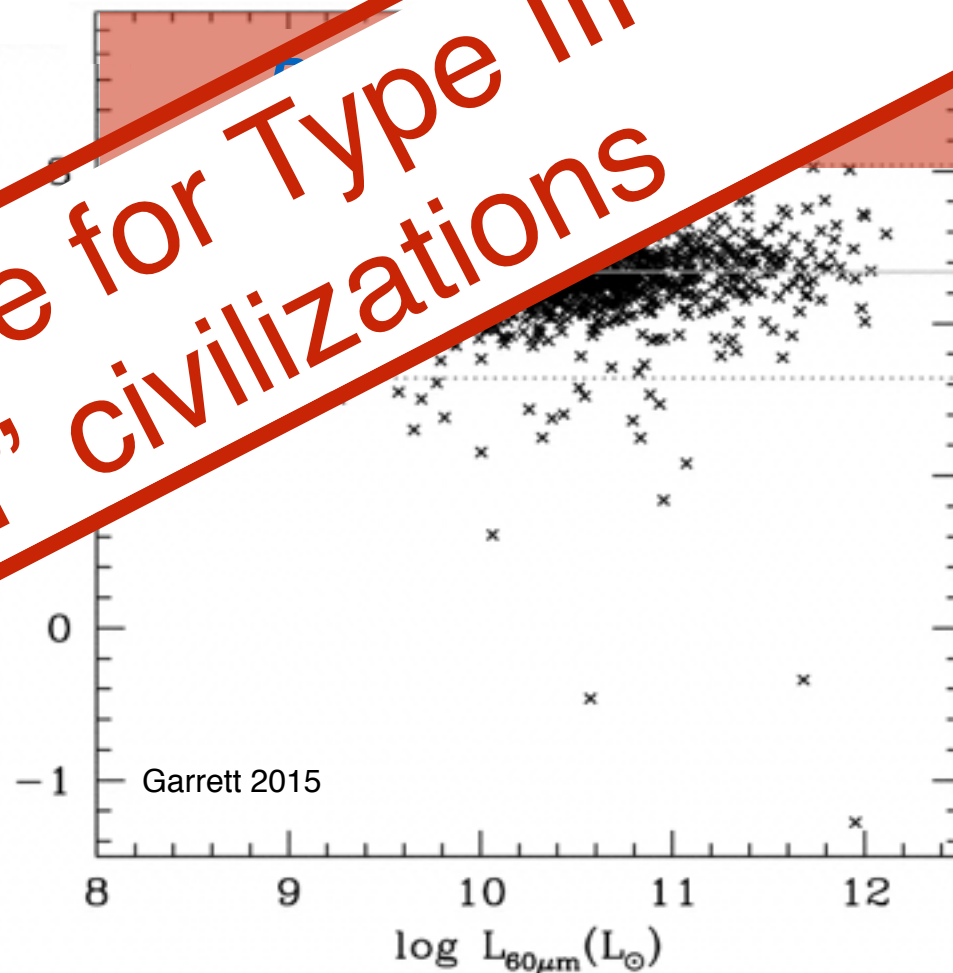


# Another global scaling law for galaxies:

Yun, Carilli & Condon 2001



Again outliers



No evidence for Type III  
"hot tech" civilizations





### YOU MIGHT LIKE



**2 cartoon cats teach you 9 cat idioms from around the world in...**  
Babbel YouTube



**Sparta : The Strategy Game Phenomenon of 2015**  
Sparta Online Game



**10 Craziest Tattoos Ever!**  
Share The Buzz



**10 Celebs Who Married Ordinary People Or Fans**  
Celebriplanet.com

## The truth is NOT out there: Astronomer uses highly sensitive telescope to search for alien civilisations...but finds nothing

- Search of nearby galaxies failed to find heat signatures of advanced life
- Instead, abnormally hot galaxies could be explained by clouds of dust
- Head of Netherlands Institute for Radio Astronomy said it shows we are unlikely to make contact with advanced alien civilisations any time soon

By RICHARD GRAY FOR MAILONLINE

PUBLISHED: 10:41 GMT, 16 September 2015 | UPDATED: 11:40 GMT, 16 September 2015

Share
 




**377** shares

**237**  
View comments

It will be bad news for those hoping we are on the verge of making contact with alien life in nearby galaxies – there may be nothing out there after all.

A leading astronomer has concluded that advanced civilisations are very rare or 'entirely absent' in the galaxies surrounding our own.

He used sensitive new te  
that might indicate the pr

Scroll down for video

### YOU MIGHT LIKE



2 cartoon ca  
you 9 cat idi  
around the v  
Babbel YouTube



Doooog, Brighton, United Kingdom, 3 days ago

He is an alien, trying to cover up

Click to rate



41



3

Sparta Online Game

CelebriplaneL.com

## The truth is NOT out there: Astronomer uses highly sensitive telescope to search for alien civilisations...but finds nothing

- Search of nearby galaxies failed to find heat signatures of advanced life
- Instead, abnormally hot galaxies could be explained by clouds of dust
- Head of Netherlands Institute for Radio Astronomy said it shows we are unlikely to make contact with advanced alien civilisations any time soon

By RICHARD GRAY FOR MAILONLINE

PUBLISHED: 10:41 GMT, 16 September 2015 | UPDATED: 11:40 GMT, 16 September 2015

Share
 




**377** shares

**237**  
View comments

It will be bad news for those hoping we are on the verge of making contact with alien life in nearby galaxies – there may be nothing out there after all.

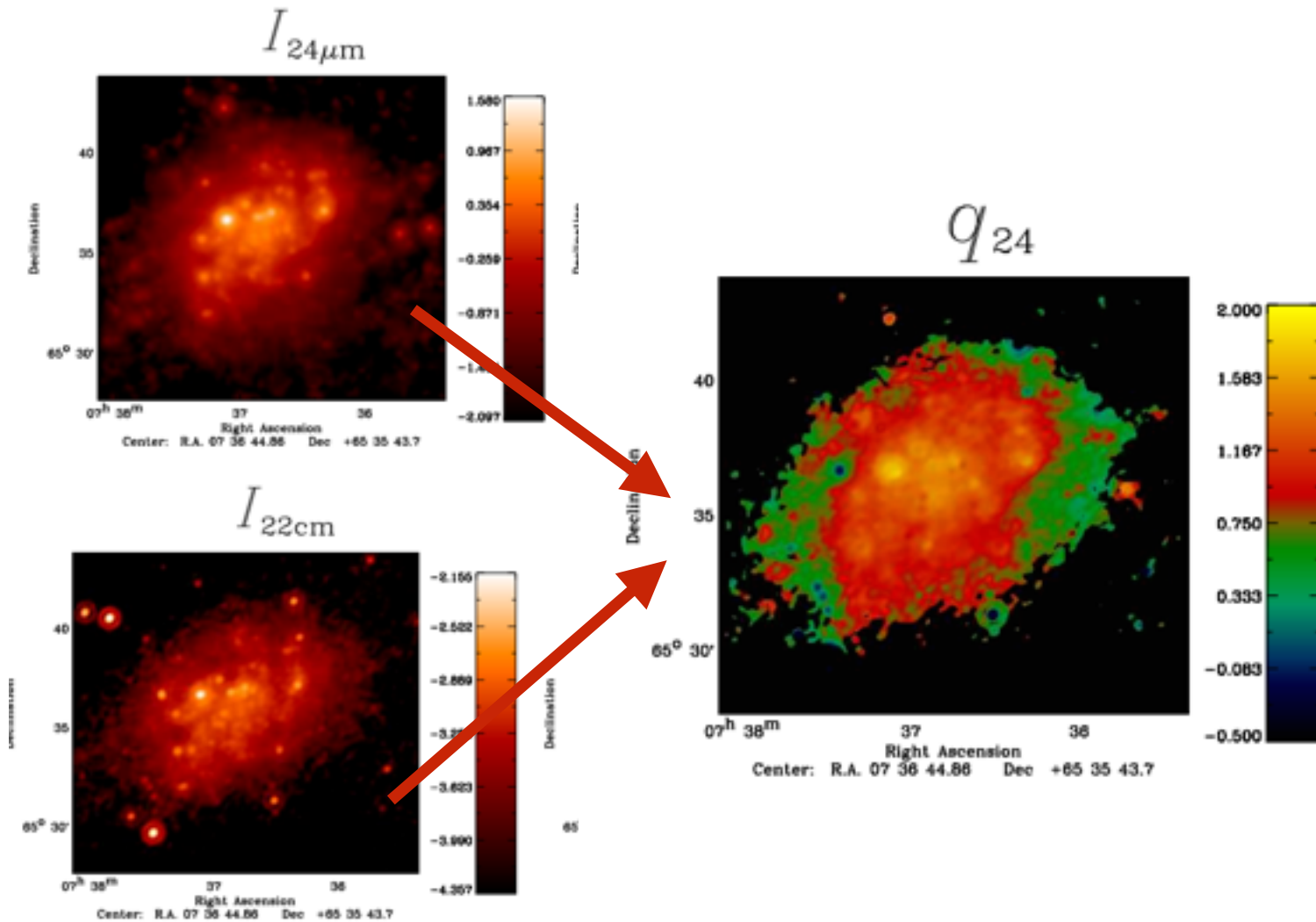
A leading astronomer has concluded that advanced civilisations are very rare or 'entirely absent' in the galaxies surrounding our own.

He used sensitive new te  
that might indicate the pr

Scroll down for video

FIR/MIR-radio correlation holds on *sub-galactic* (kpc) scales (Murphy et al 2006)...

**=> technique can be extended to transition Type II/IIIs:**

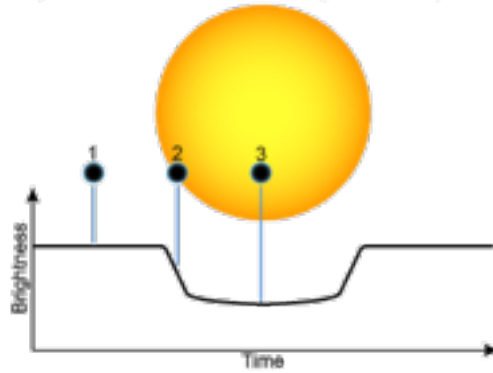


# What about Type I-IIs ?

Kepler

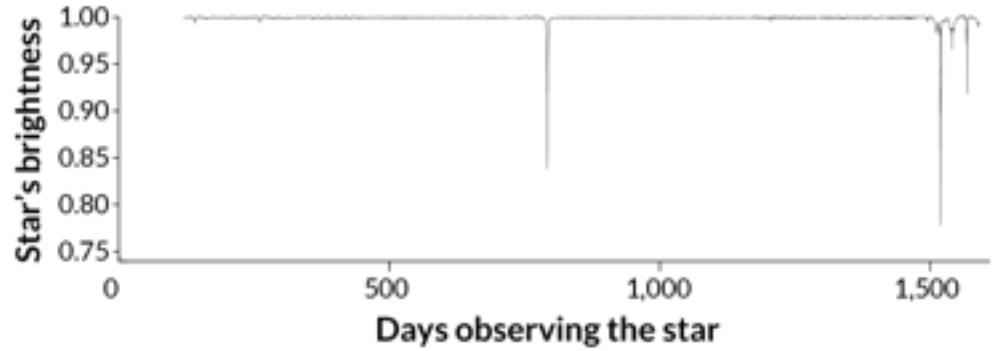


Light Curve of a Star During Planetary Transit

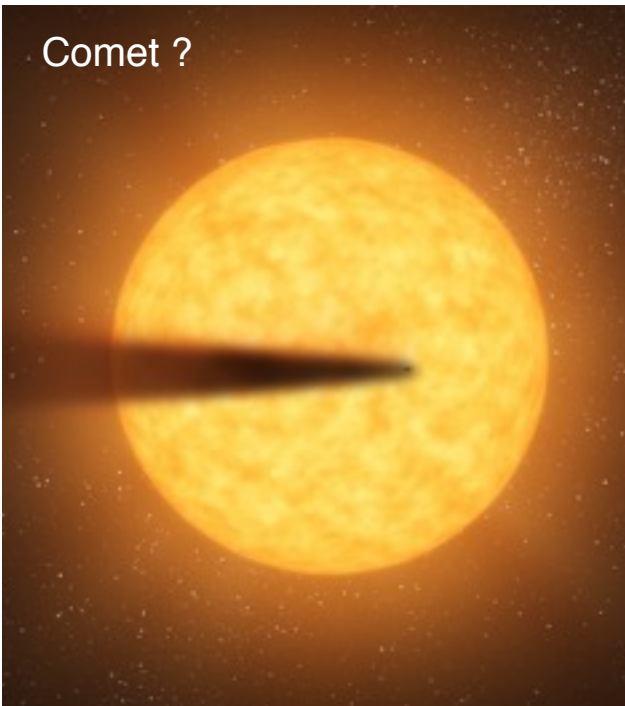


Kepler KIC 8462852 light curve - Tabby's star

Boyajian et al. 2015



Comet ?



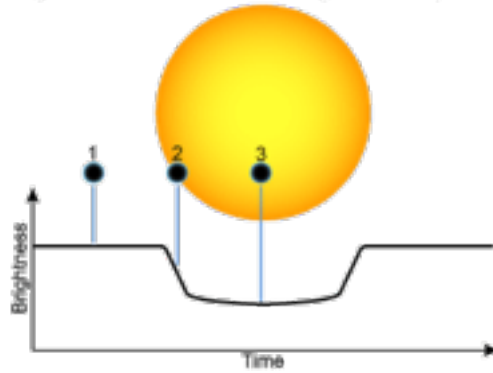


# What about Type I-IIs ?

Kepler

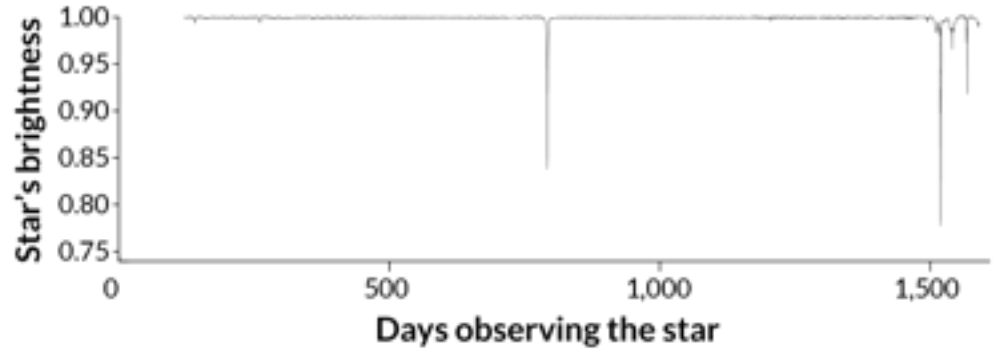


Light Curve of a Star During Planetary Transit

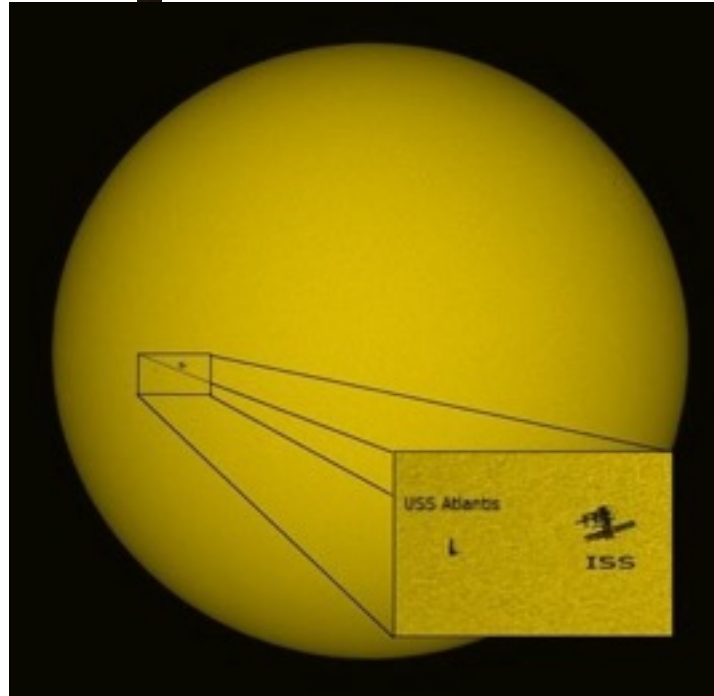
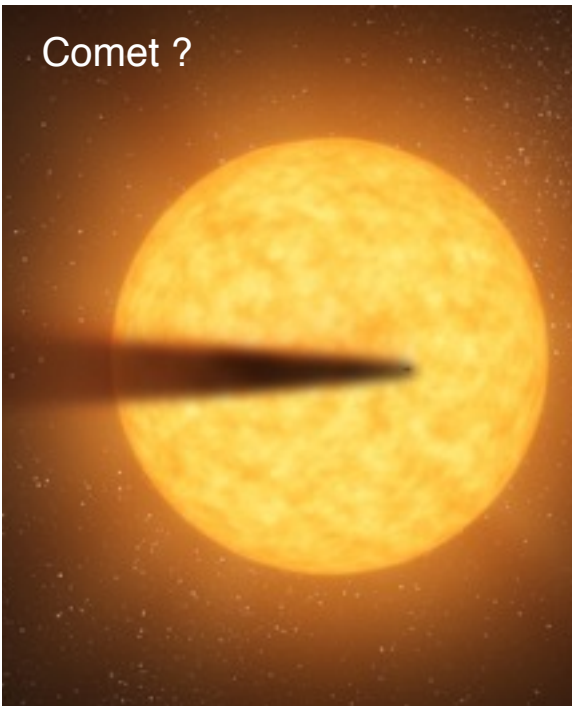


Kepler KIC 8462852 light curve - Tabby's star

Boyajian et al. 2015



Comet ?



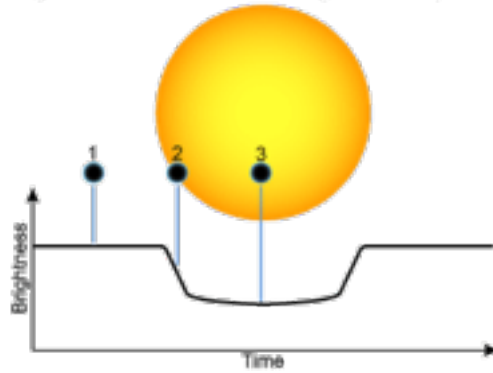


# What about Type I-IIs ?

Kepler

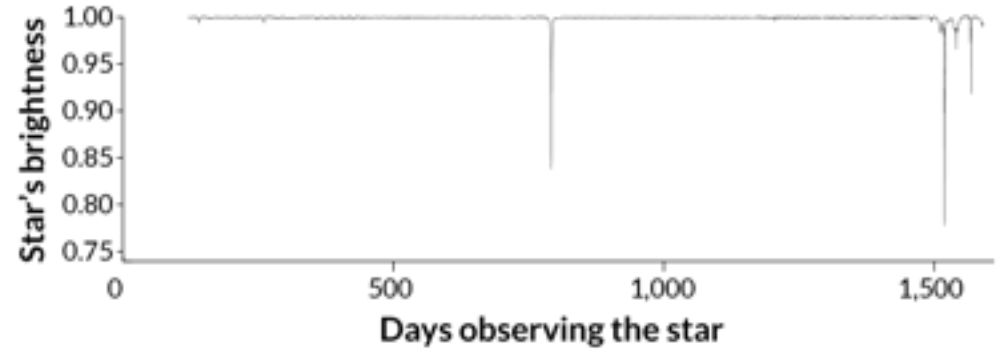


Light Curve of a Star During Planetary Transit

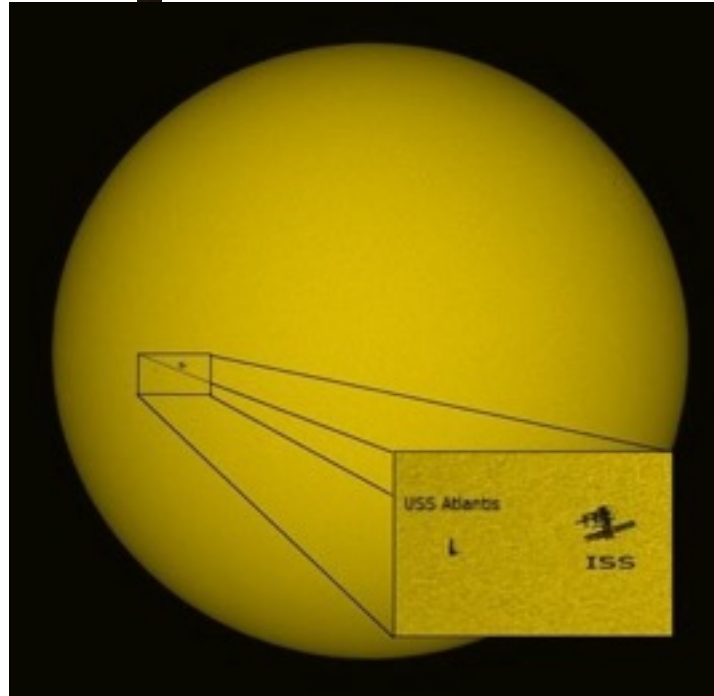
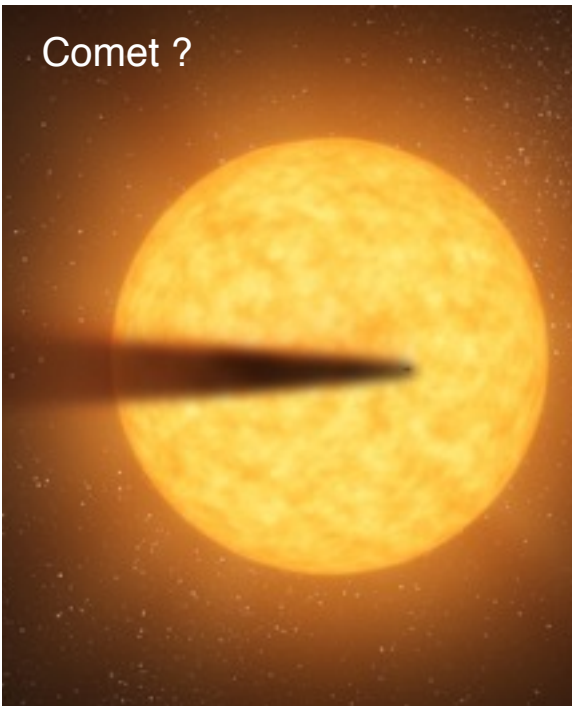


Kepler KIC 8462852 light curve - Tabby's star

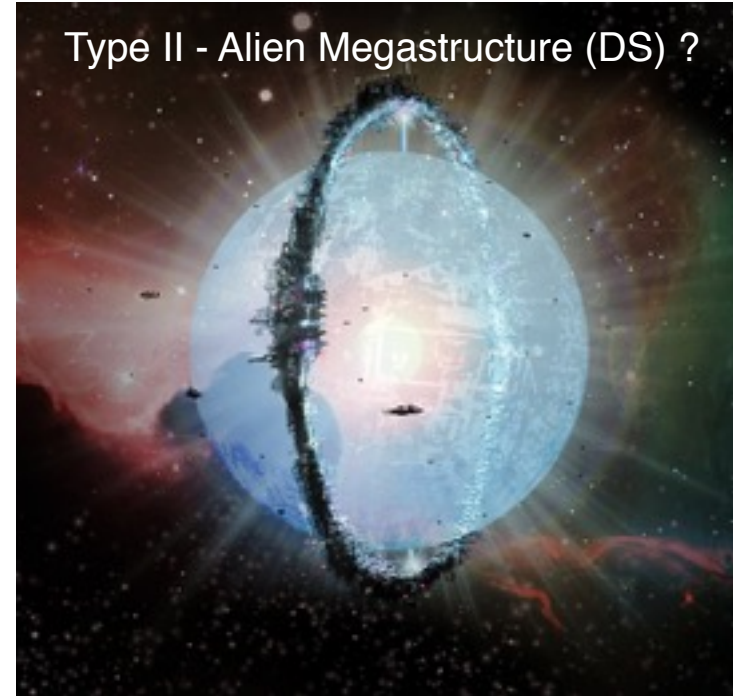
Boyajian et al. 2015



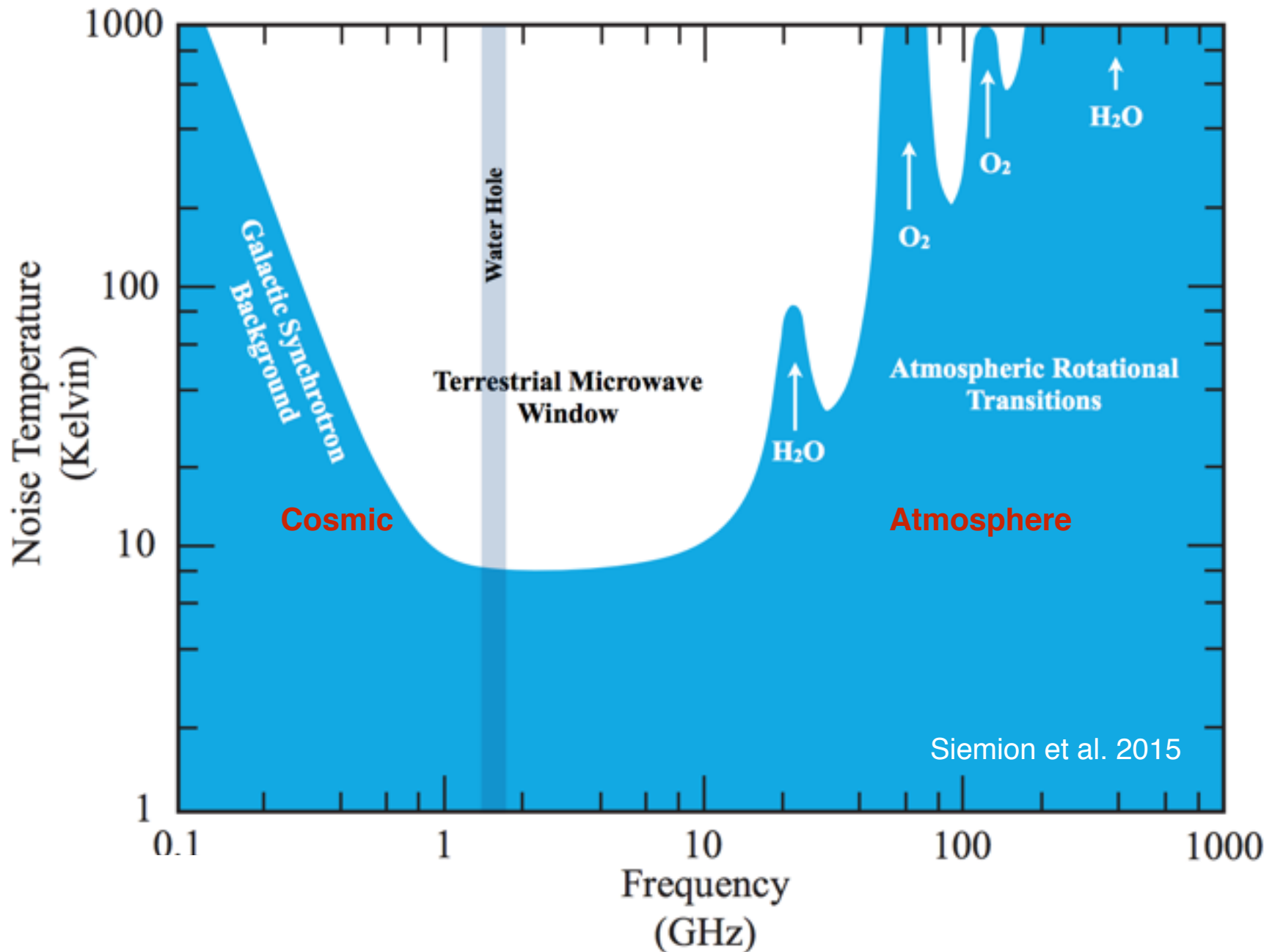
Comet ?



Type II - Alien Megastructure (DS) ?



# “THz (sub-mm) SETI: beyond the water hole”

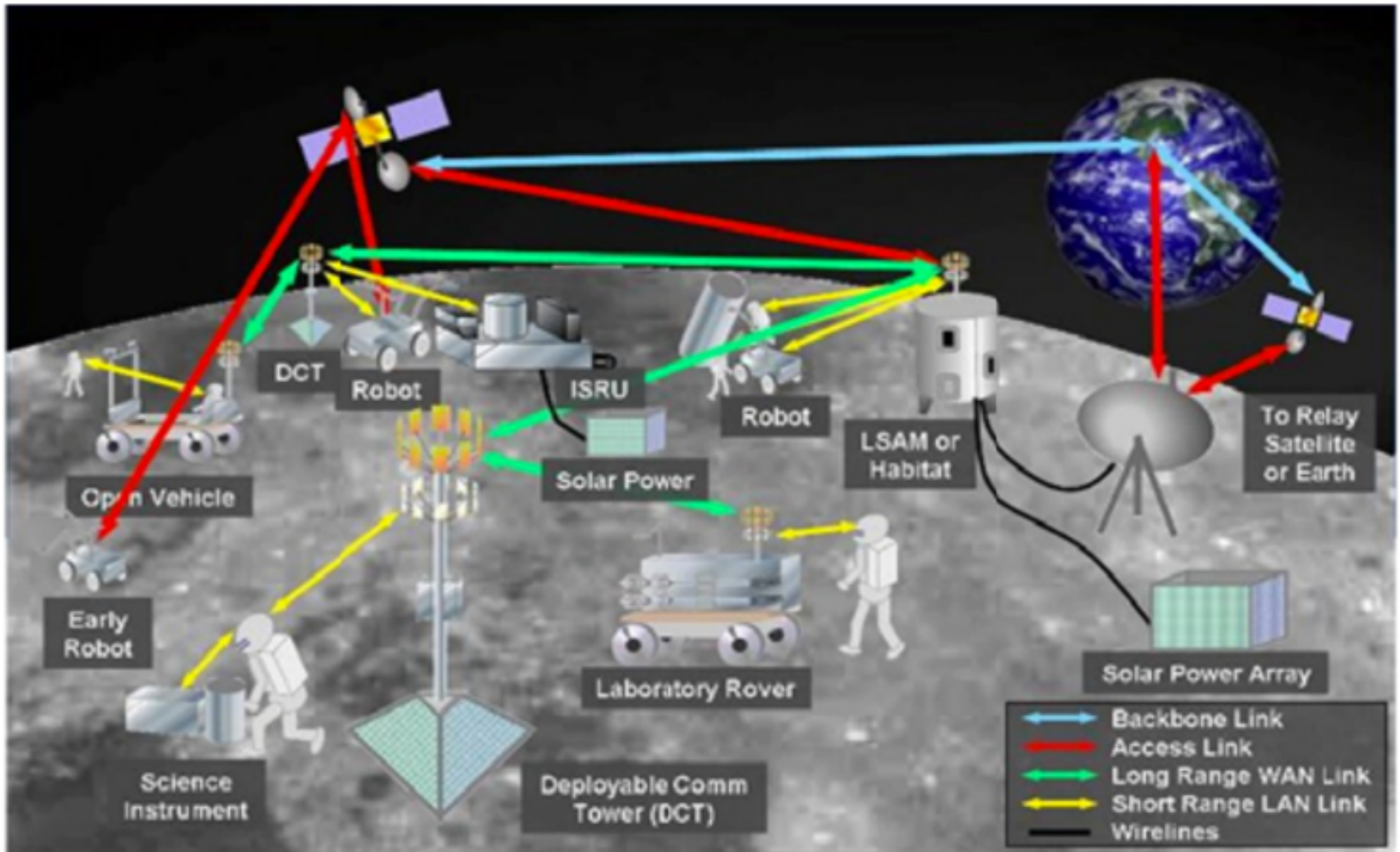


# ALMA





# Future examples - space communications (Hwu et al 2013):



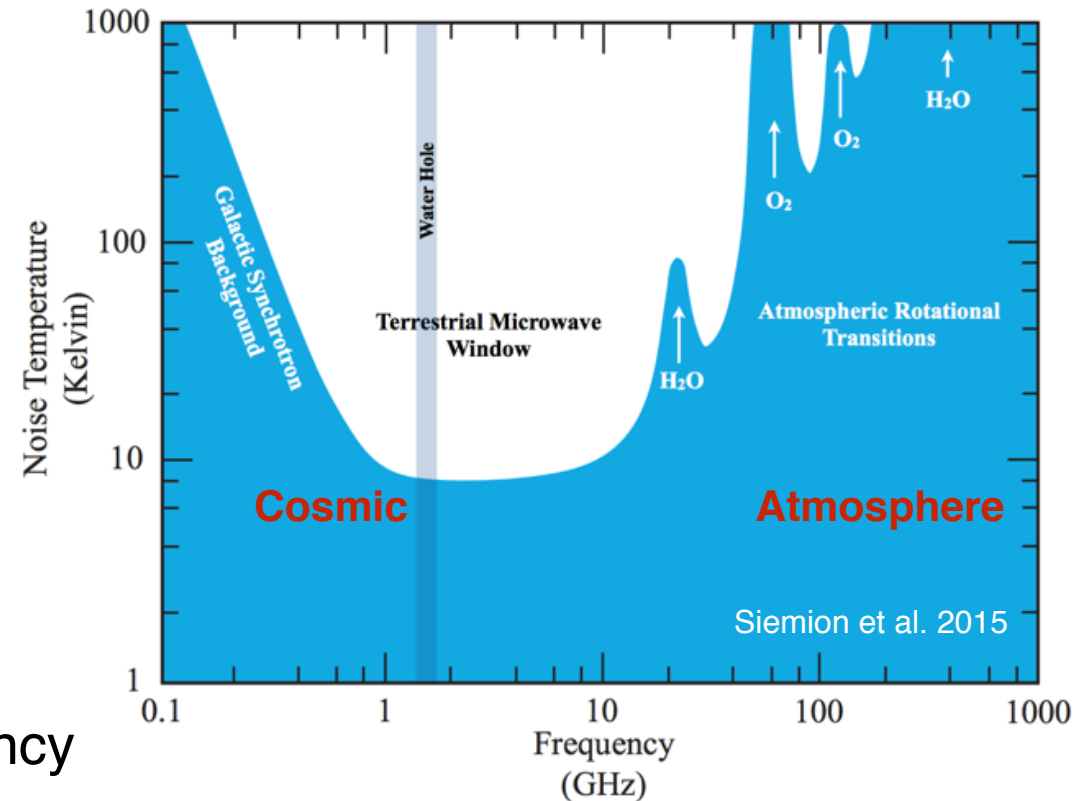
# “THz (sub-mm) SETI: beyond the water hole”

## Rapid progress in THz technologies:

- large bandwidth & resolution
- physical size/weight/mobility
- limited RFI, sparse occupation
- non-ionising
- unimpeded by dust, gas etc.
- covert advantages...

## Current disadvantages:

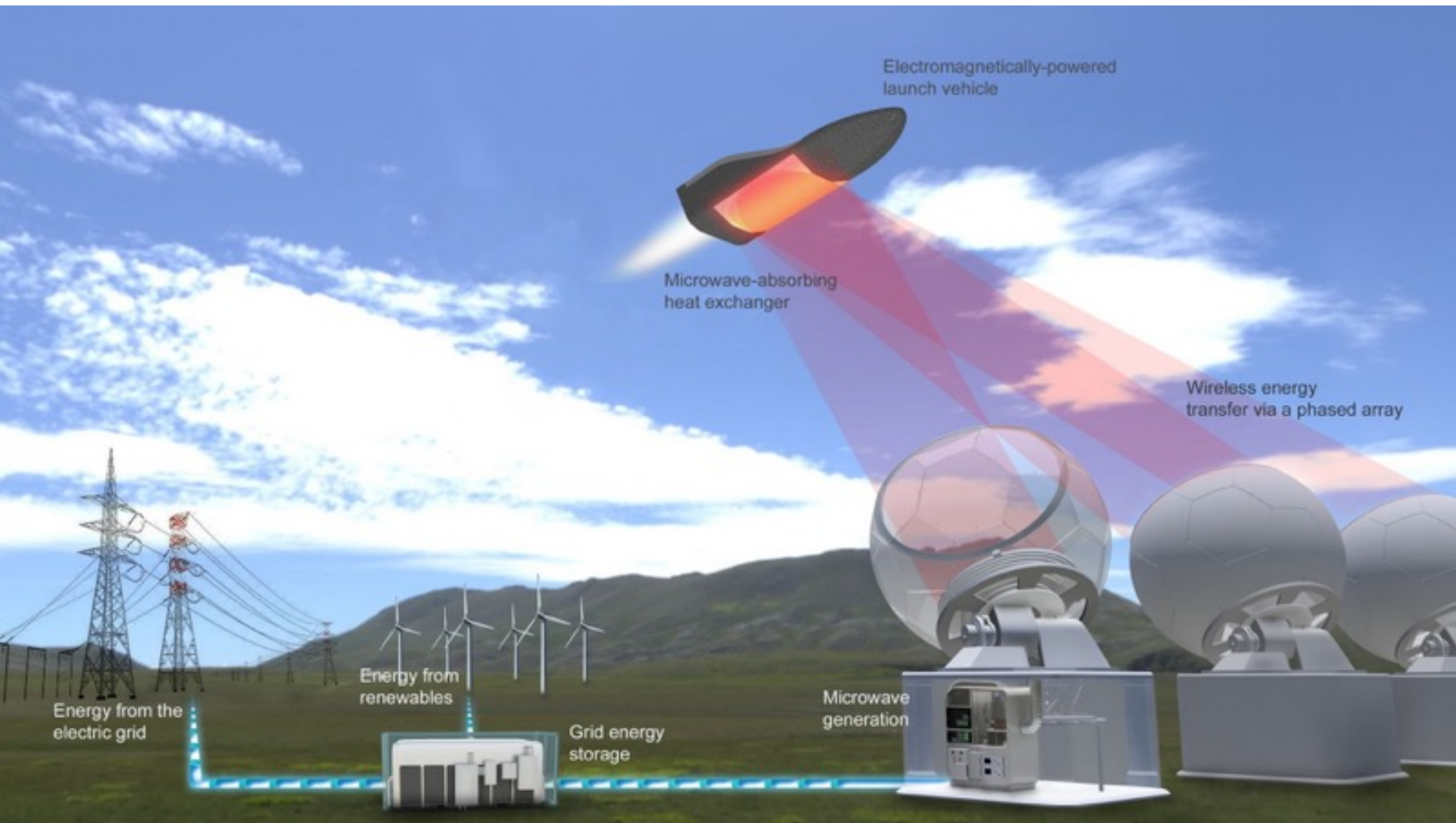
- sources rel. low power & poor efficiency
- atmospheric absorption



**Interesting region of e-m spectrum for communication  
SETI searches ?**



# Future examples - wireless energy transfer e.g. Benford & Benford 2016.

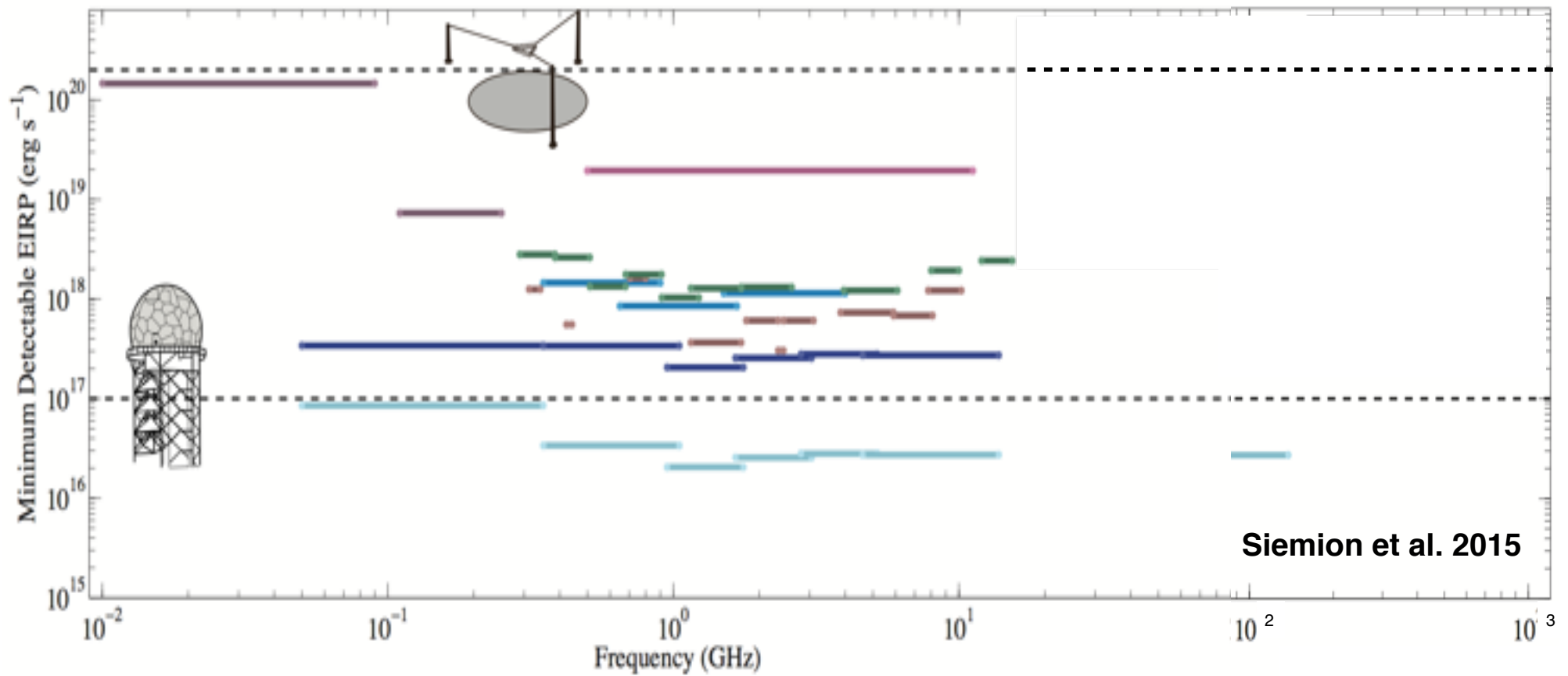
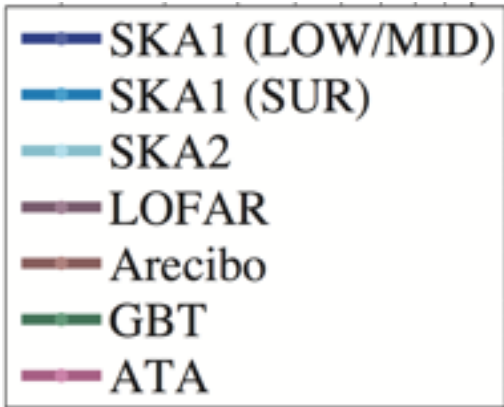


# ALMA

ALMA:  $\sigma \sim 50 \sqrt{(\Delta\nu/t)}$  Jy at 100 GHz (3mm).

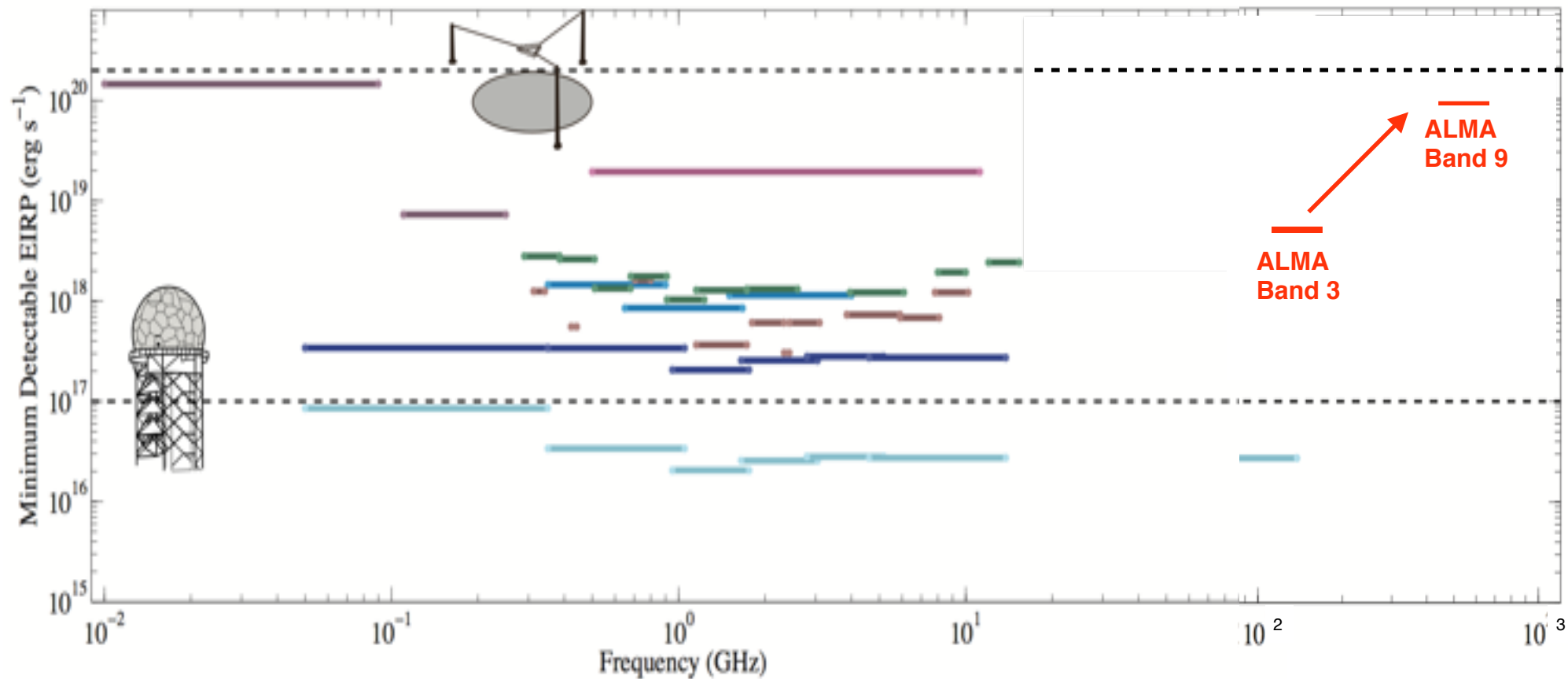
SKA-1:  $\sigma \sim 2 \sqrt{(\Delta\nu/t)}$  Jy at 1.4 GHz (20 cm).





- SKA1 (LOW/MID)
- SKA1 (SUR)
- SKA2
- LOFAR
- Arecibo
- GBT
- ATA

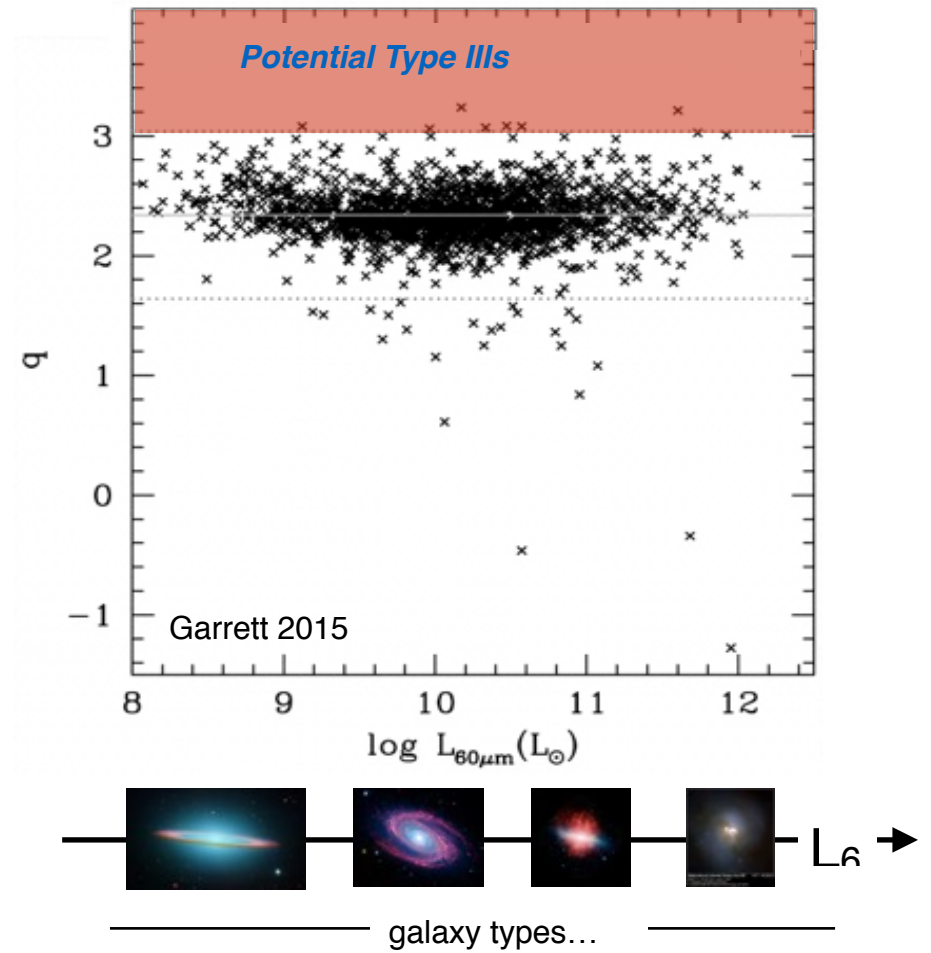
For narrow band signals large doppler corrections to be solved for...





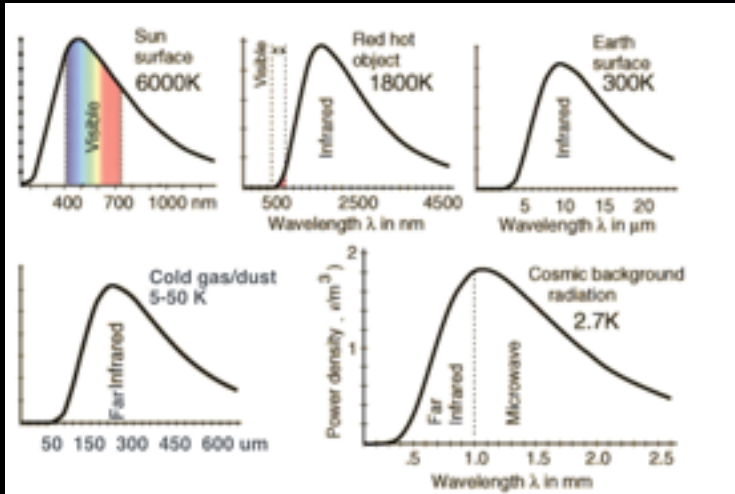
# Why outliers are interesting...

First and second laws of thermodynamics...

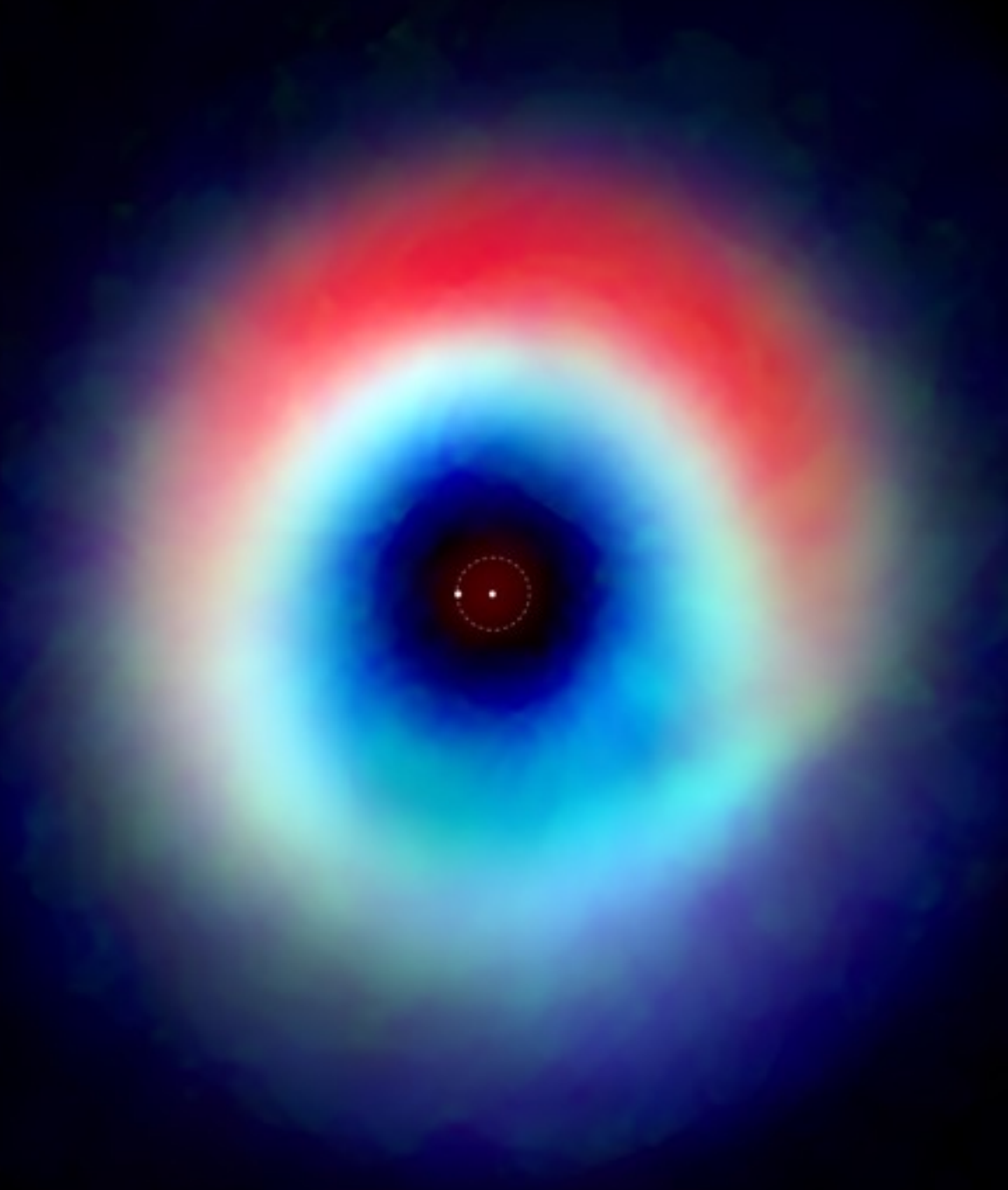




**Boltzmann's law:  $T_{\text{waste}} = (L_{\text{waste}}/A\sigma)^{1/4}$**



**ALMA: proto-planetary  
disk around binary  
system.**



# Conclusions

**Astronomical data is? contaminated by artificial emission generated by advanced ET civilisations at some level.**

**Outliers in Galaxy scaling laws (e.g. IR-radio correlation) already place limits on contamination by adv. civilisations.**

**FIR/sub-mm domain might be a good place to search for excess emission from energy efficient civilizations.**

**The sub-mm wavelength domain might provide an interesting extension to communication SETI searches.**

**Advanced (Kardashev Type III) civilisations do not exist (or are extremely rare) in the local Universe ( $< 1E-5$ ).**