



Magnetic chaos hidden in the Whirlpool Galaxy



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NGC1068



M51

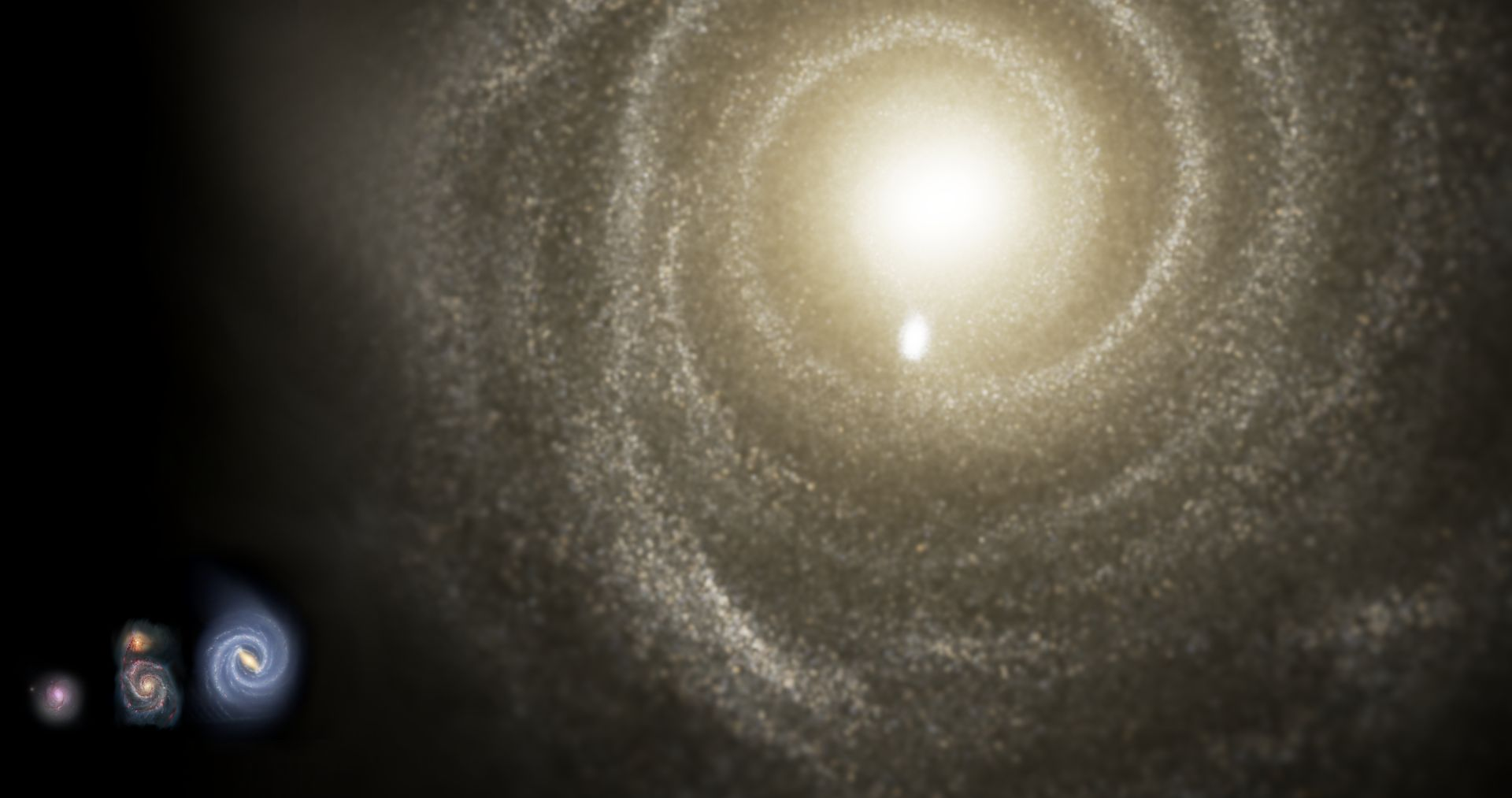


Milky way



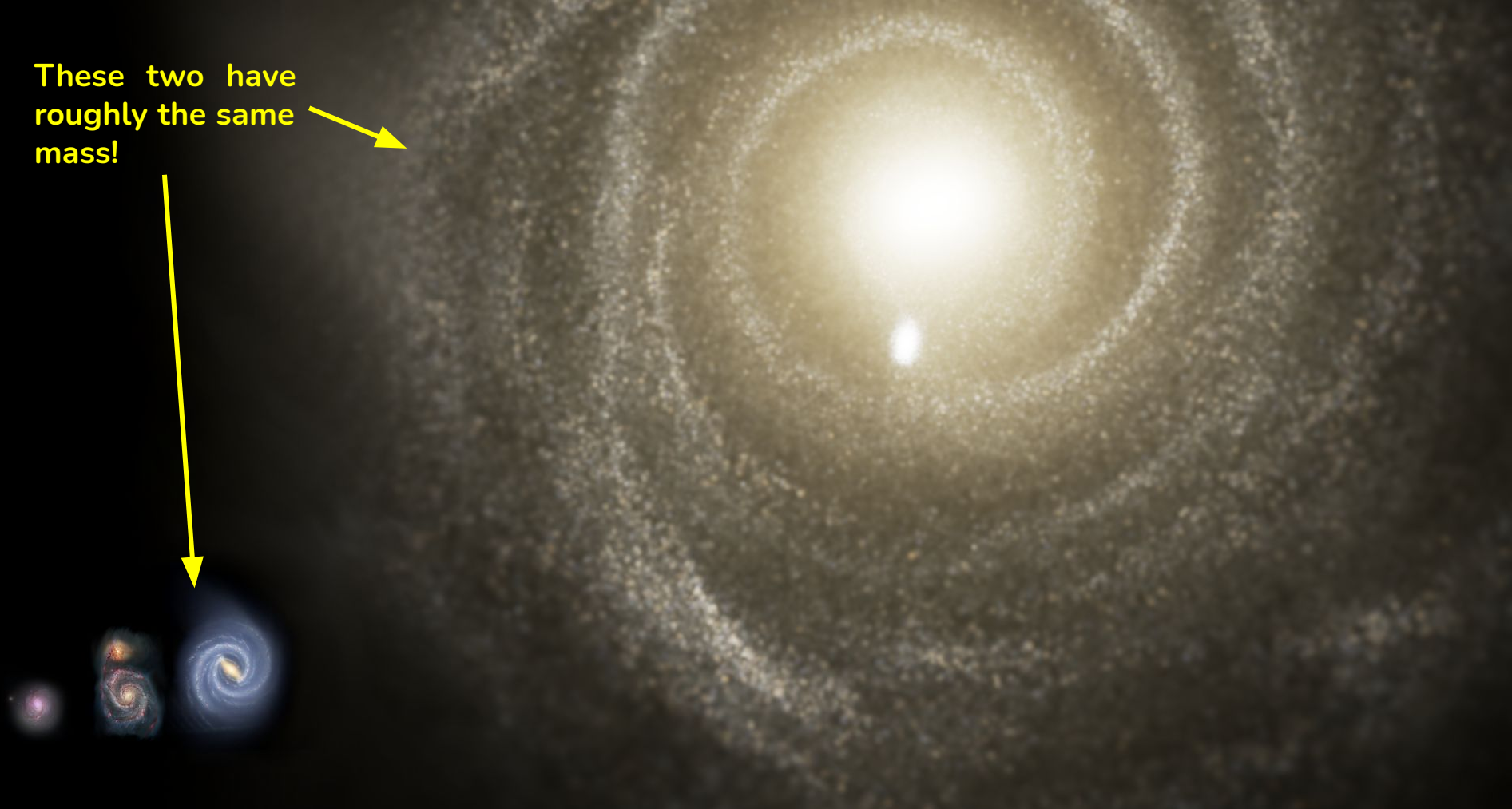
20 kpc





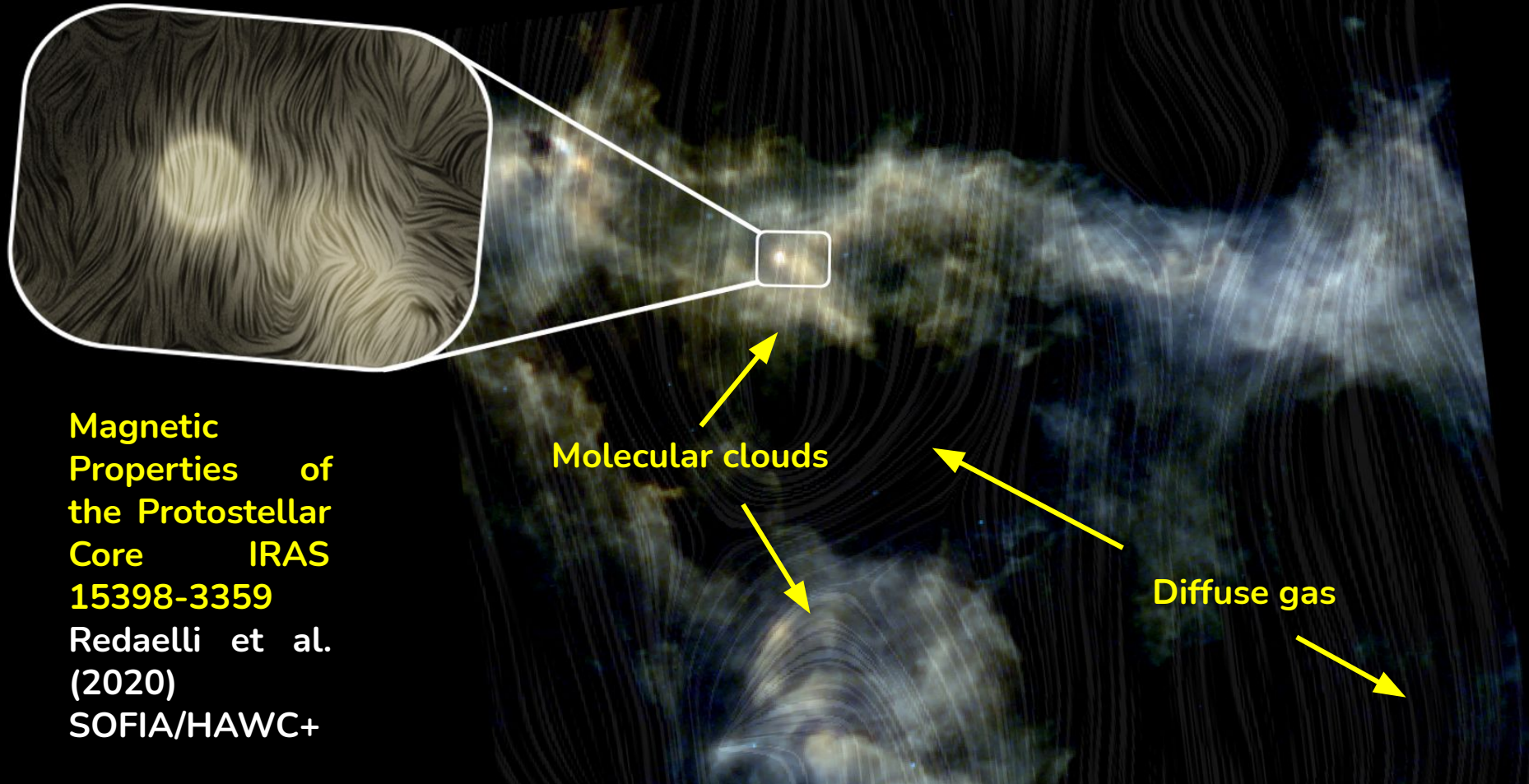
Illustris TNG50 simulation scaled to the real size of Malin 1

These two have
roughly the same
mass!



Illustris TNG50 simulation scaled to the real size of Malin 1

Magnetic fields are vital for star formation



Magnetic
Properties of
the Protostellar
Core IRAS
15398-3359

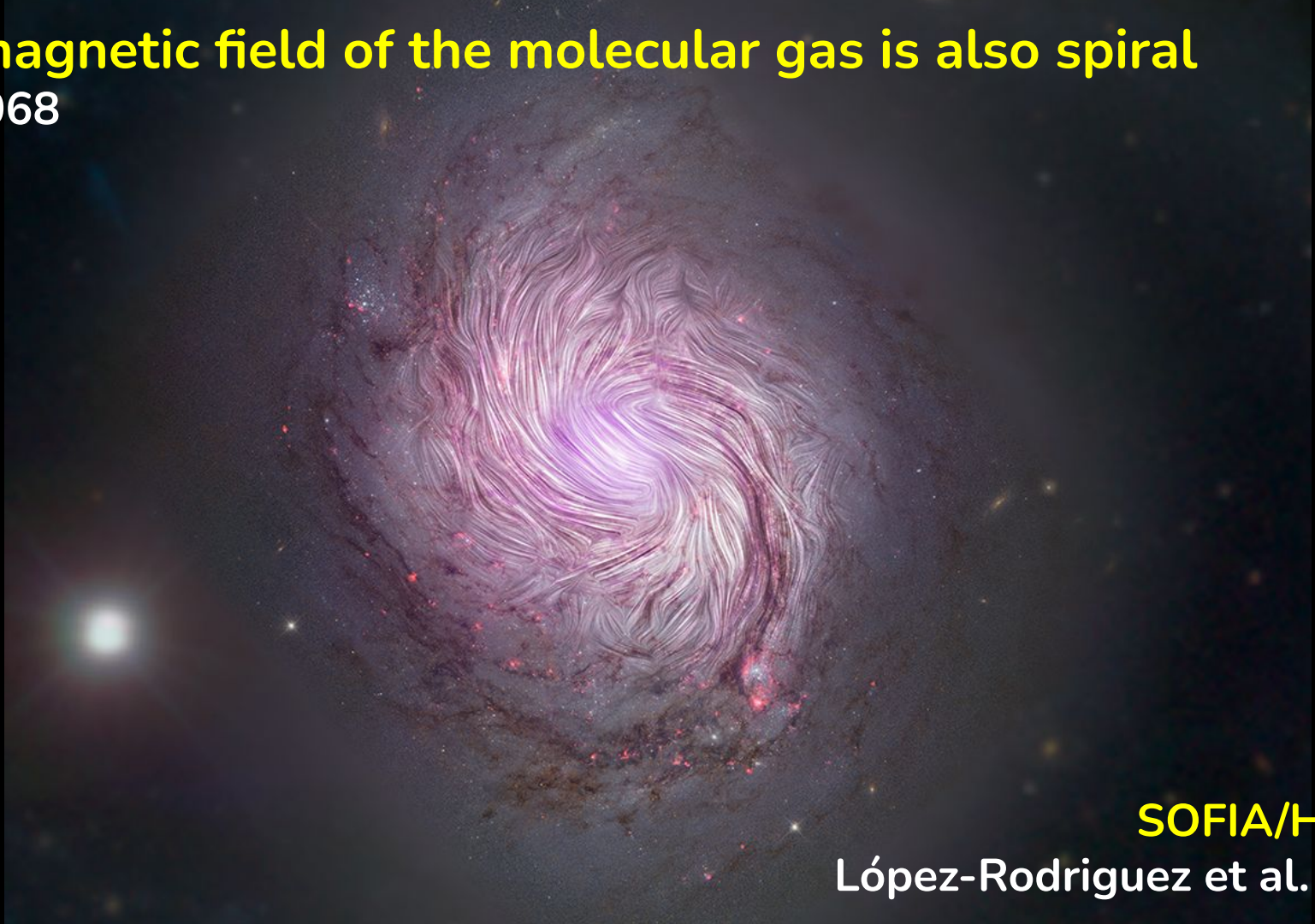
Redaelli et al.
(2020)
SOFIA/HAWC+

Molecular clouds

Diffuse gas

The magnetic field of the molecular gas is also spiral

NGC1068



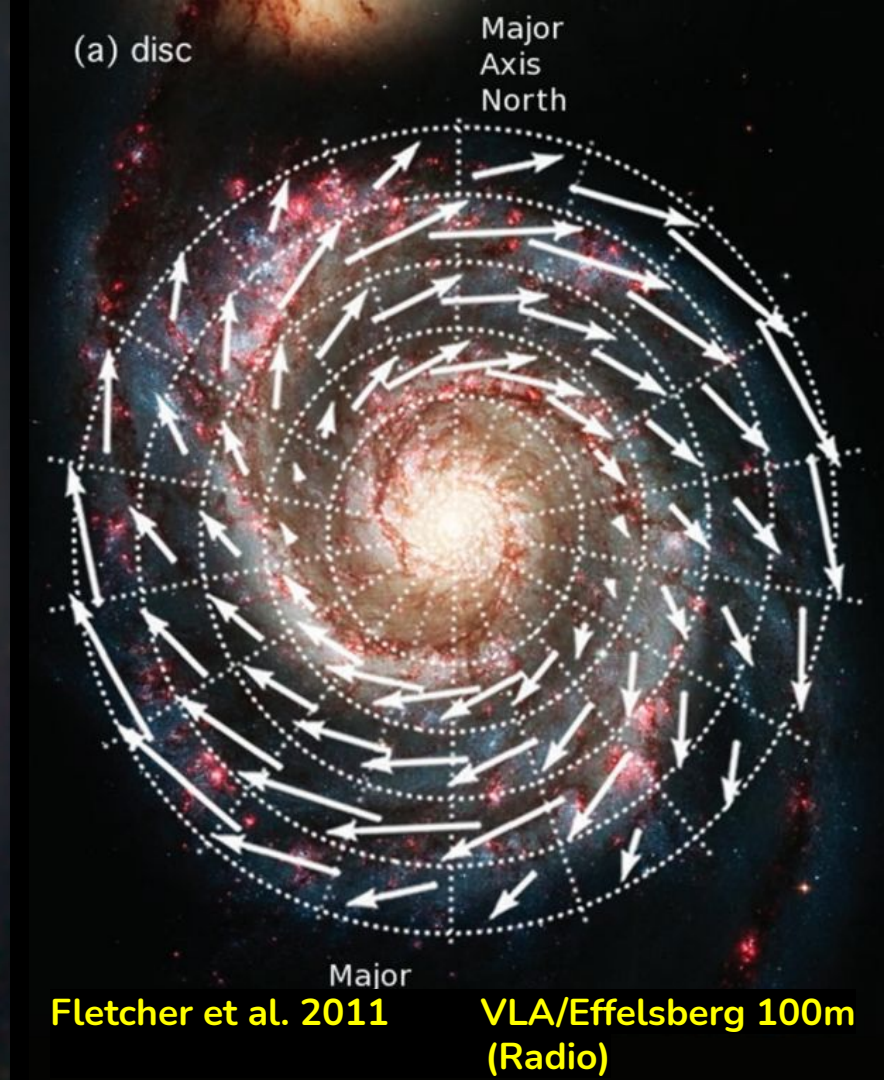
SOFIA/HAWC+

López-Rodríguez et al. (2020)

Galaxies are space magnets



SOFIA/HAWC+ (Far-infrared)
López-Rodríguez et al. (2020)



(a) disc
Major Axis North

Fletcher et al. 2011 **VLA/Effelsberg 100m (Radio)**

Diffuse warm gas:
Too diffuse to condense
Detectable in radio
Since 70's

Molecular clouds:
Ready to form stars!
Detectable in far-infrared
Since 2020

In order to answer: **Do magnetic fields shape galaxies?**

First we need to address:

Magnetic field = Magnetic field ?
diffuse gas **molecular gas**

Magnetic field lines in the molecular disk of M51

Borlaff et al. (in prep)

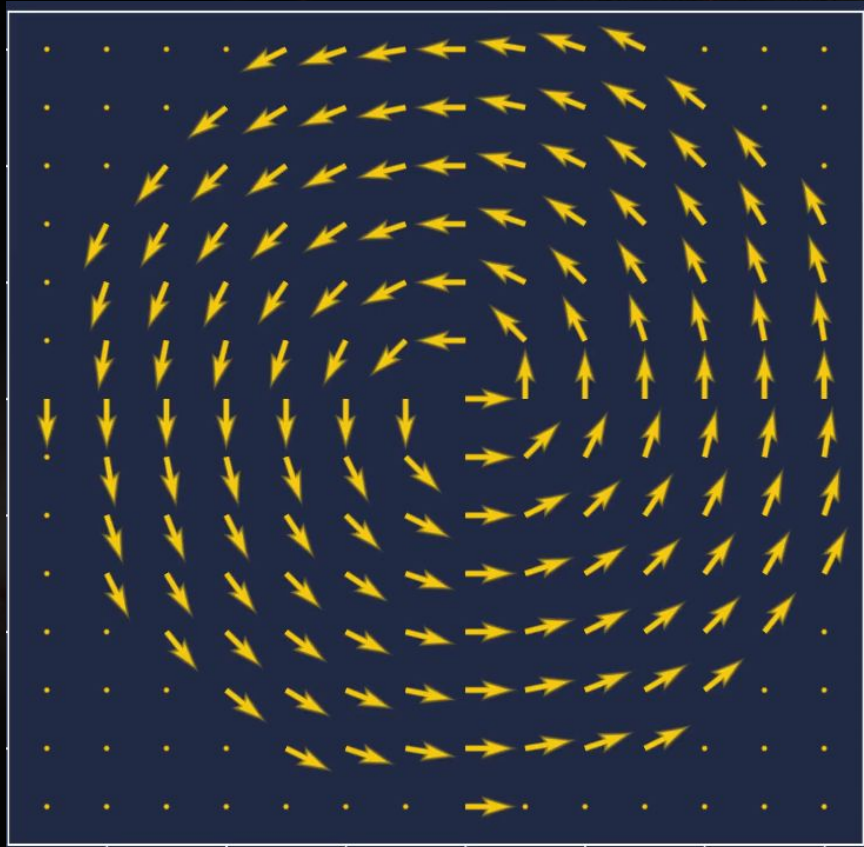


The diffuse gas and the **molecular clouds** feel the **same magnetic field?**

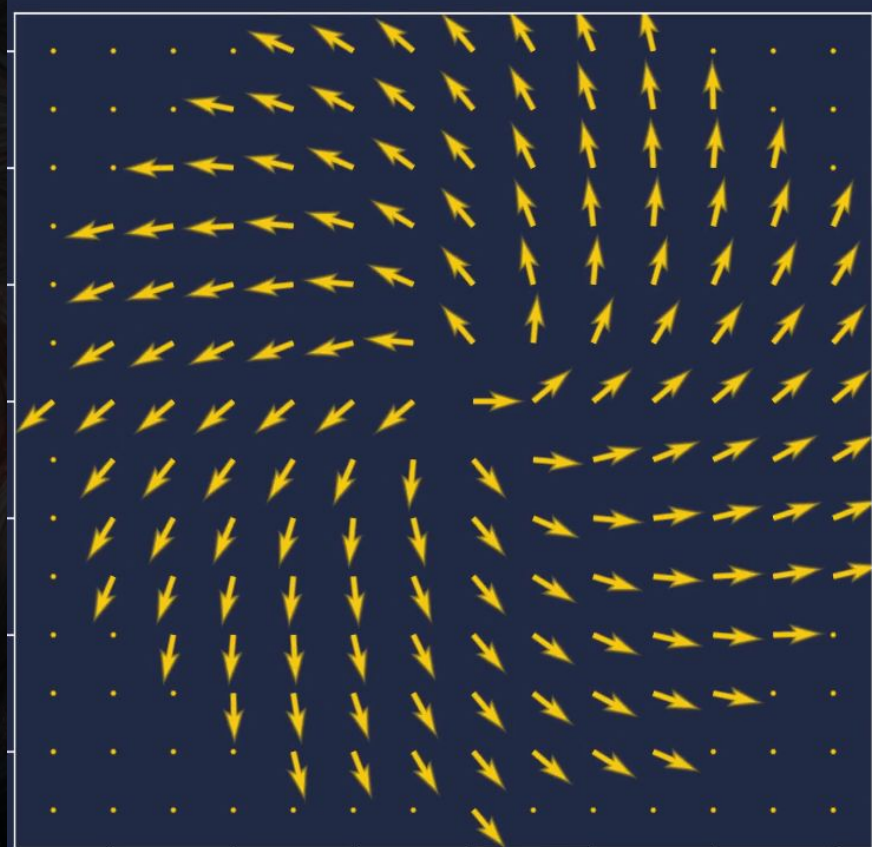
What do we compare?
Synchrotron polarized radio emission (**diffuse gas**) vs. magnetically aligned dust grain thermal FIR emission (**molecular clouds**)

How?
Magnetic **pitch angle**

**Low pitch angle
(more circular)**

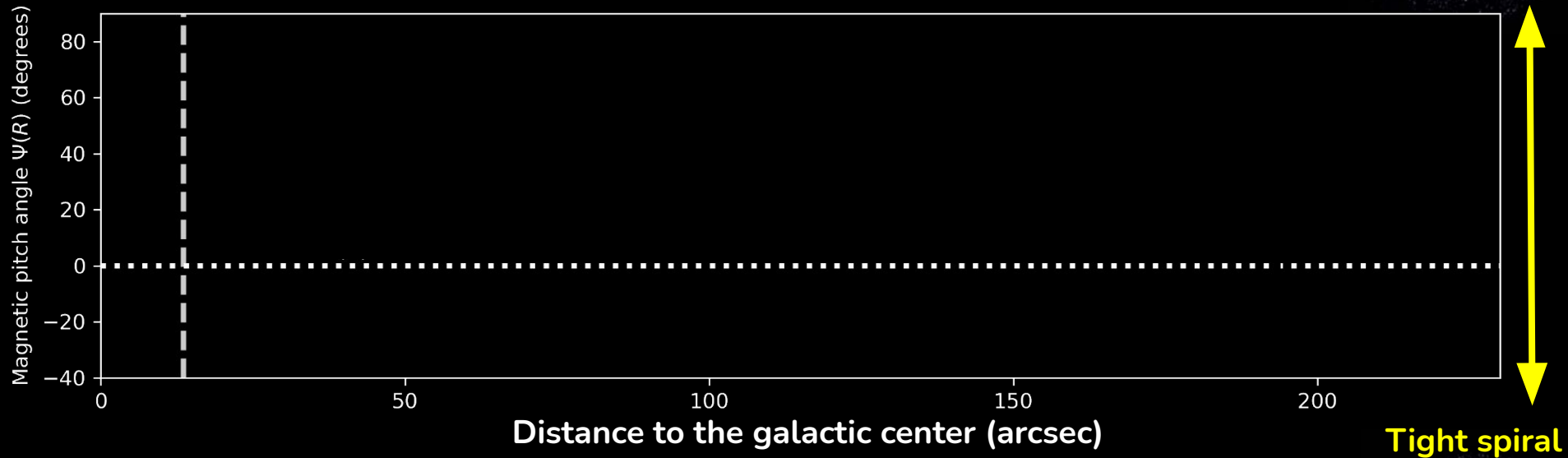


**High pitch angle
(more radial)**



Radio vs. FIR magnetic pitch angle profiles

Borlaff et al. (in prep)



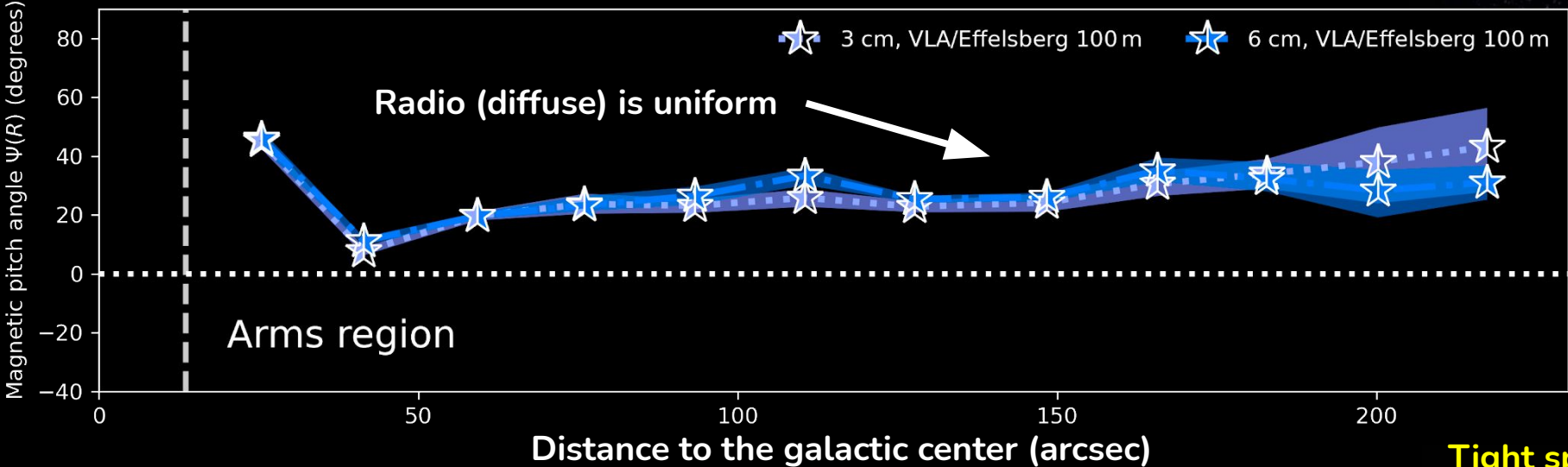
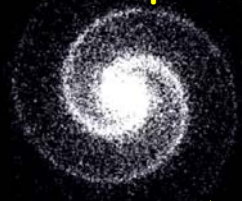
1 - The diffuse gas has a regular uniform spiral magnetic field

2 - The magnetic field of the outer molecular disk is highly distorted

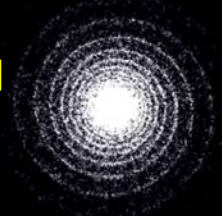
Radio vs. FIR magnetic pitch angle profiles

Borlaff et al. (in prep)

Loose spiral



Tight spiral



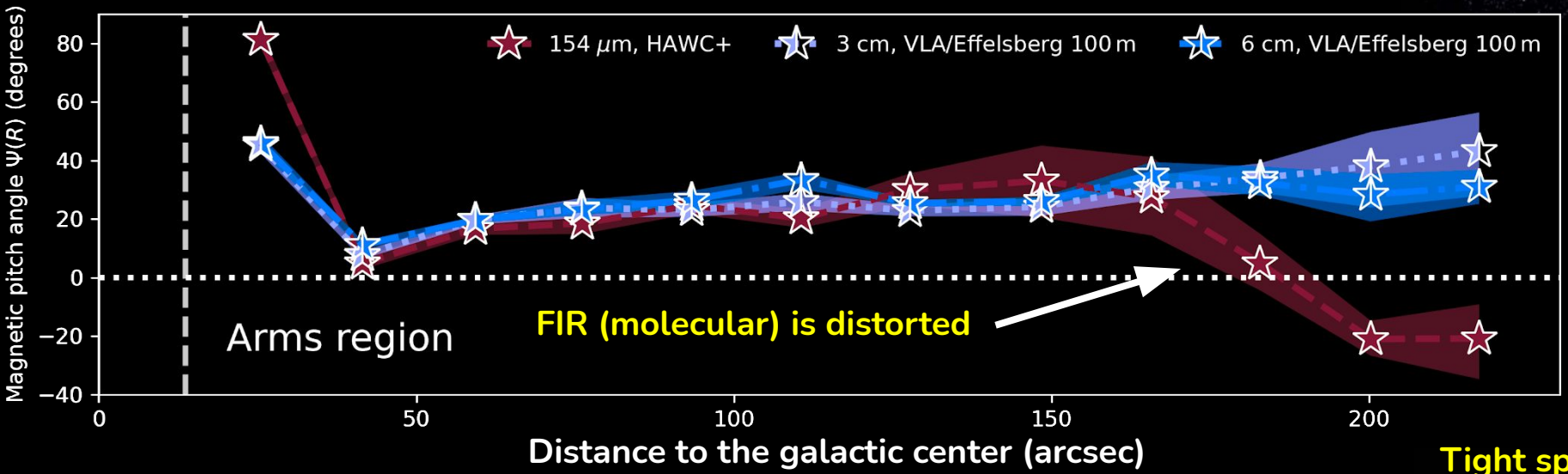
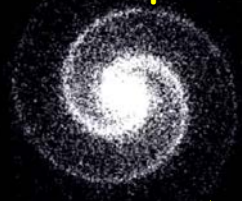
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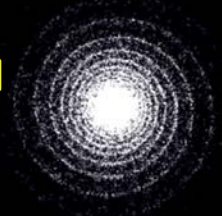
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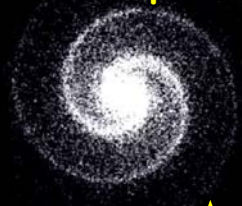


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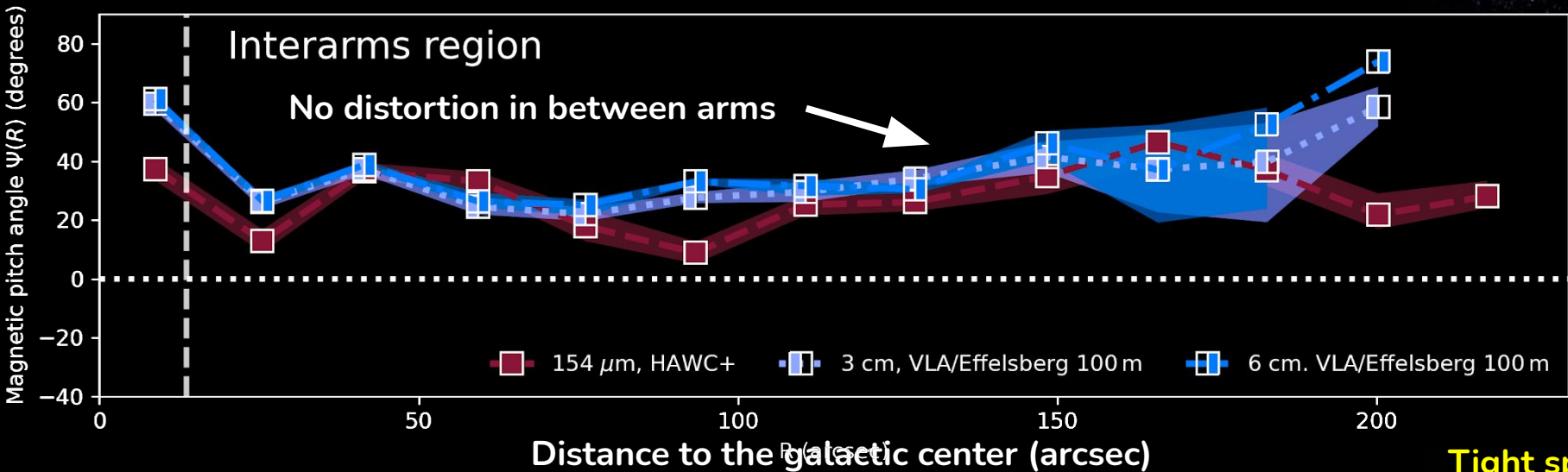
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Radio vs. FIR magnetic pitch angle profiles

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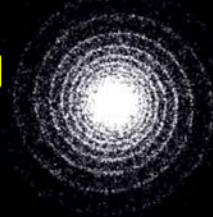


Borlaff et al. (in prep)



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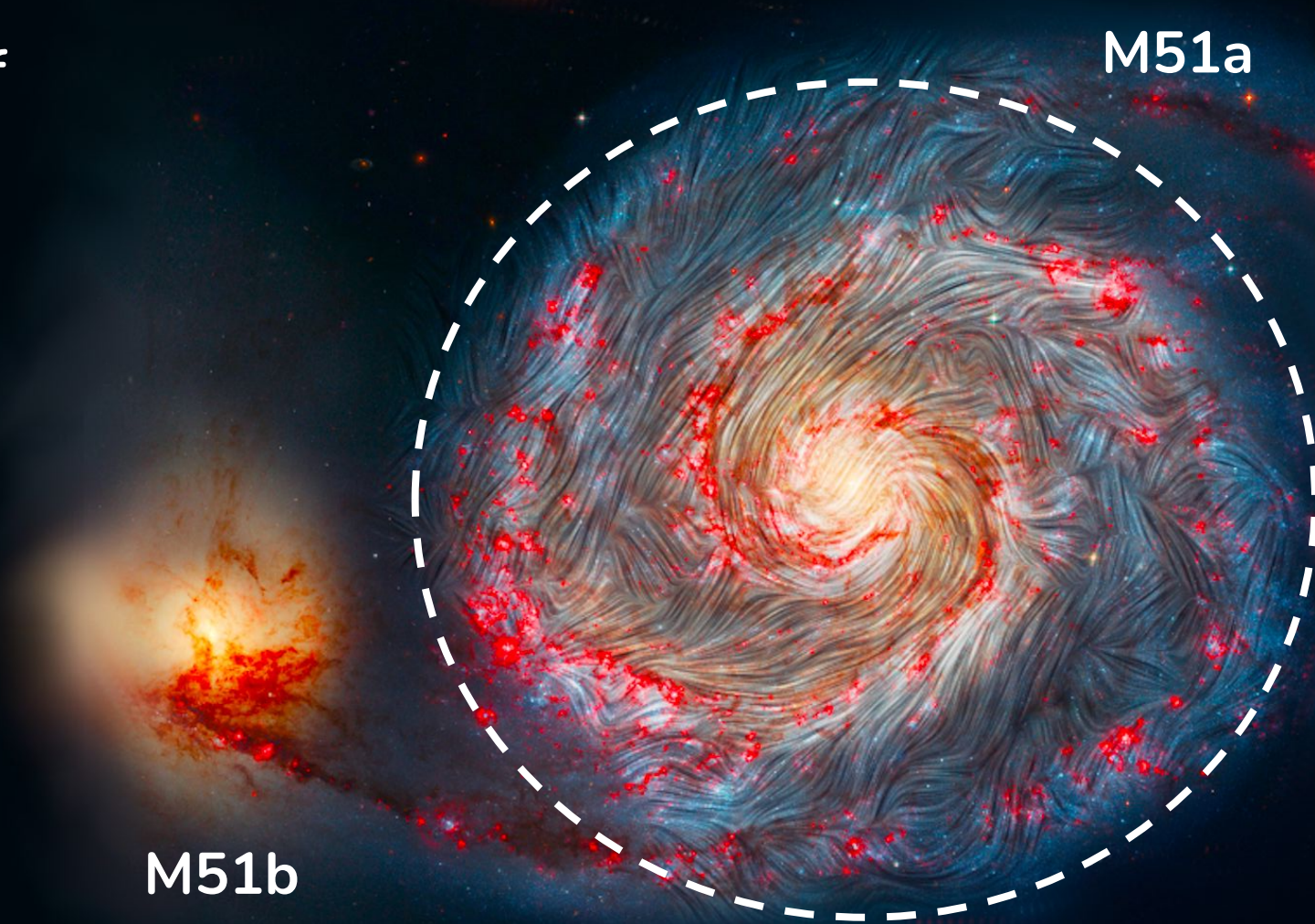
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Kinematics of
molecular
clouds



Gravitational
interaction



M51a

M51b

Kinematics of
molecular
clouds

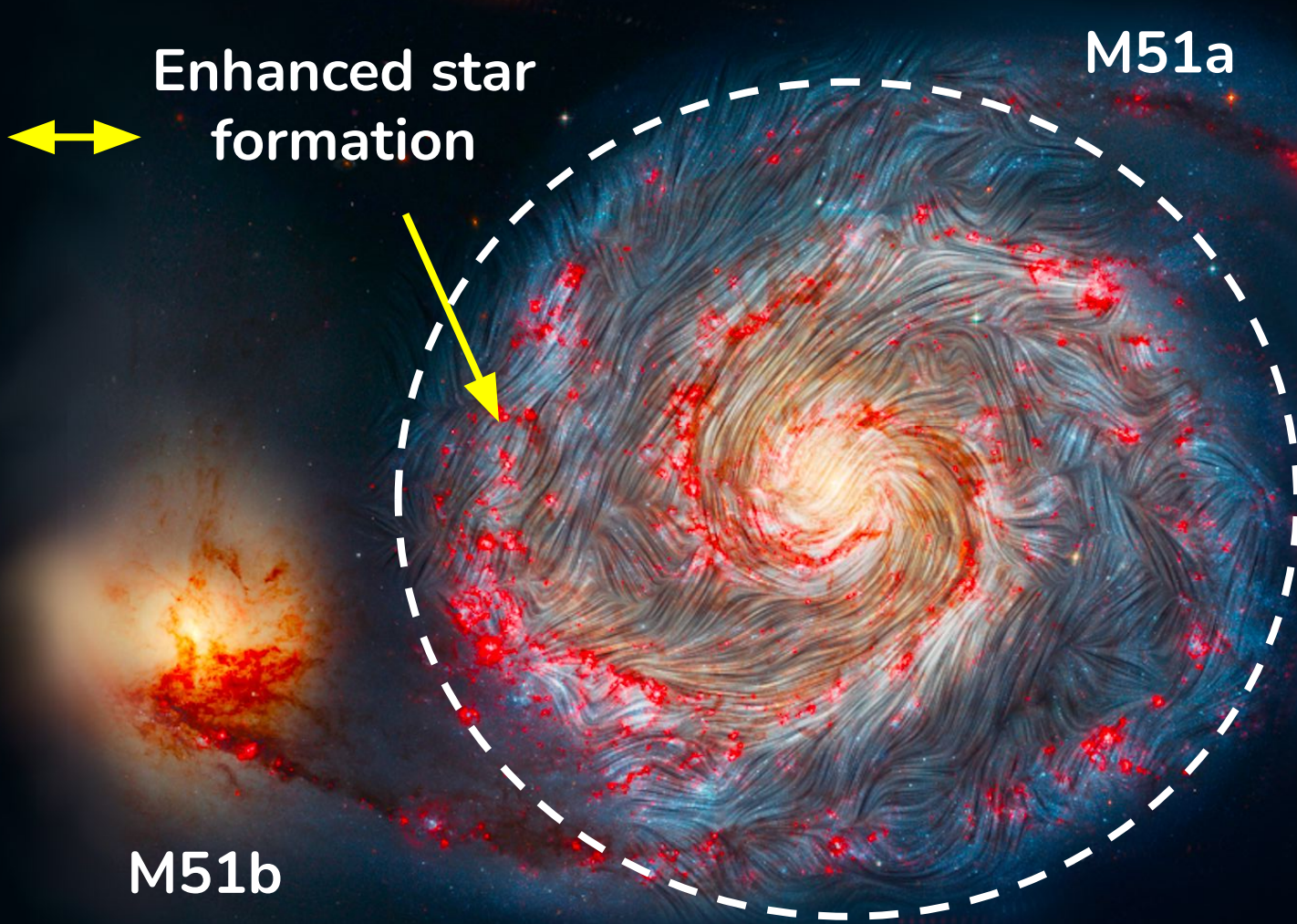
Enhanced star
formation

M51a



Gravitational
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M51b



Kinematics of
molecular
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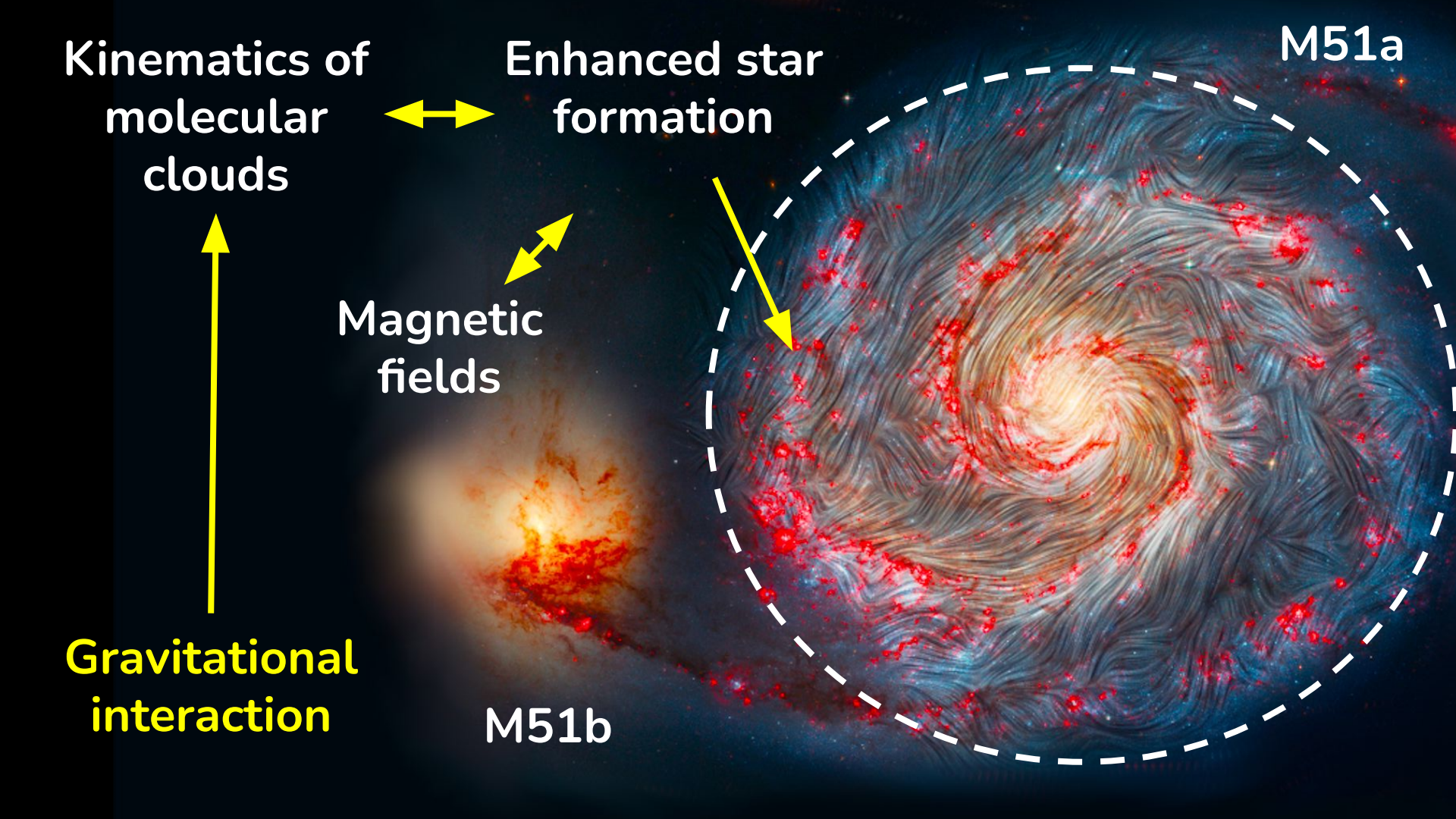
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M51b



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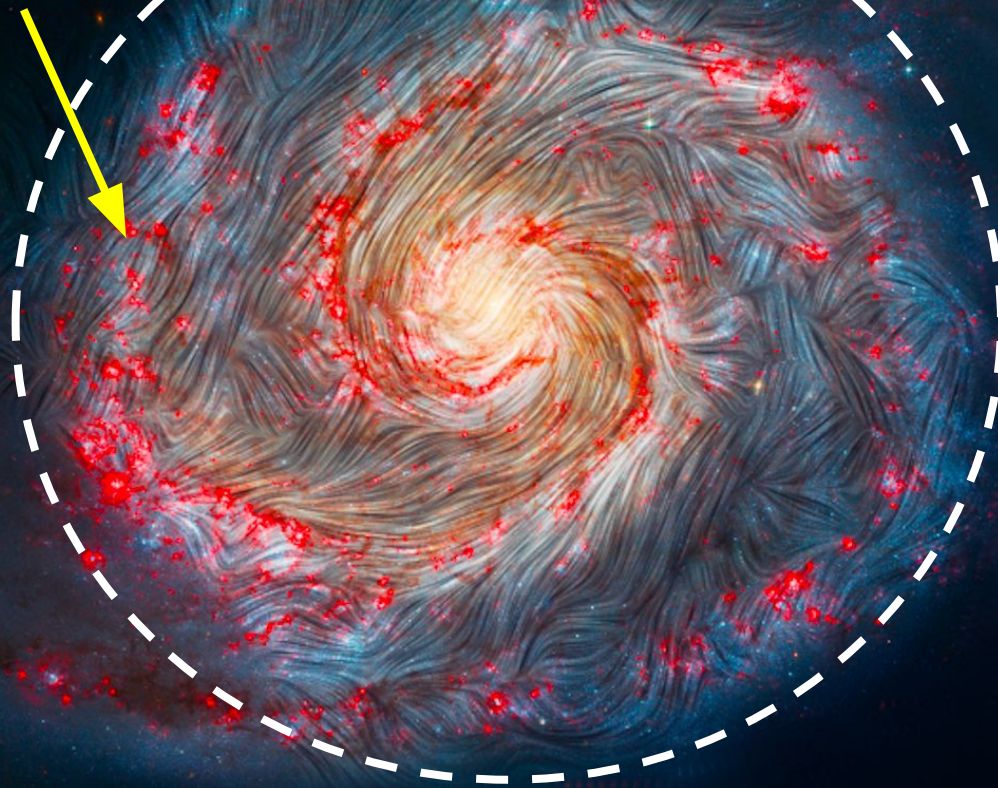
Enhanced star
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M51a

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M51b





Conclusions

Magnetic field
diffuse gas \neq Magnetic field
molecular gas

We need high resolution
far-infrared polarimetry!

Star formation, magnetic fields and
galaxy mergers are interlinked factors
that dominate the outskirts of M51

See 4:10 PM - 4:20 PM [430.01.]

The multi-phase spiral magnetic field of M51

AAS 237 Press Conference Session

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