



Welcome!

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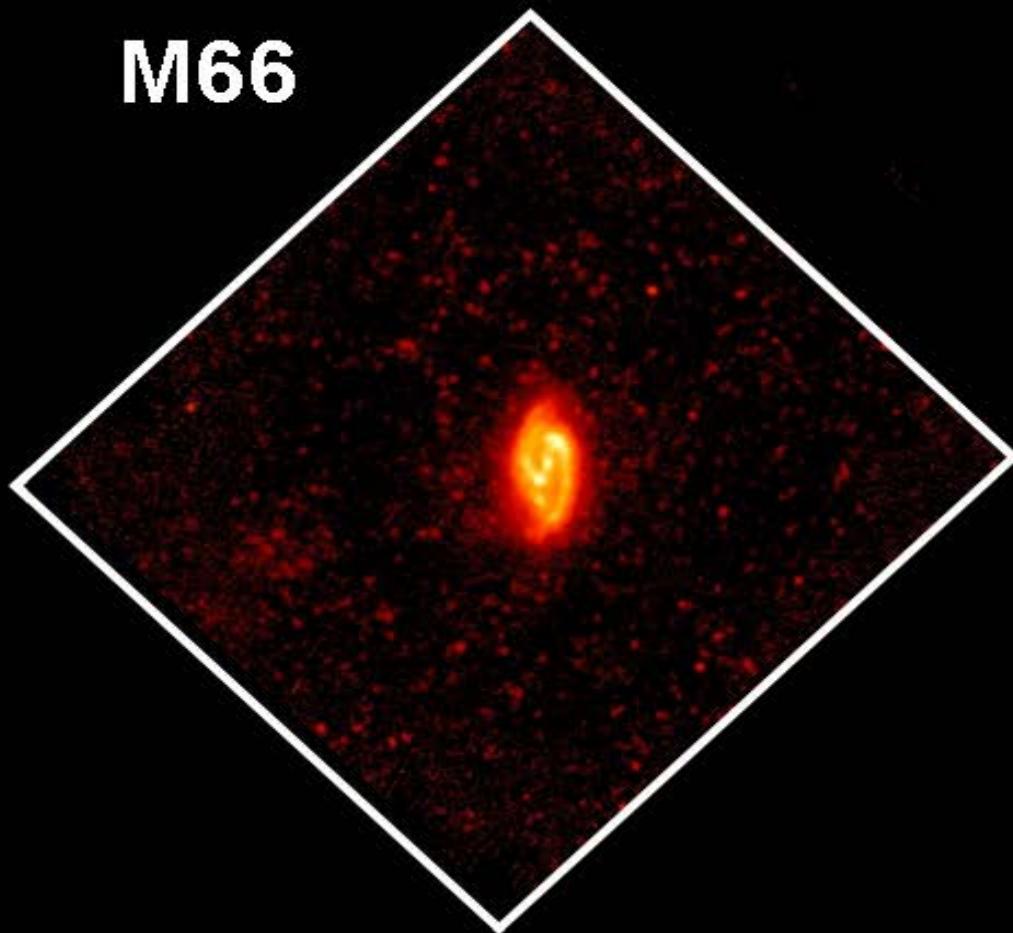
Star Formation Across Space and Time
11-14 November 2014, **ESA/ESTEC, Noordwijk**
Göran Pilbratt, SOC

Copyright: ESA/Hubble & SPHERE/ESO/NEMHES Key programme, Martin Hennebelle & Frédérique Motte,
Université Paris Diderot, France

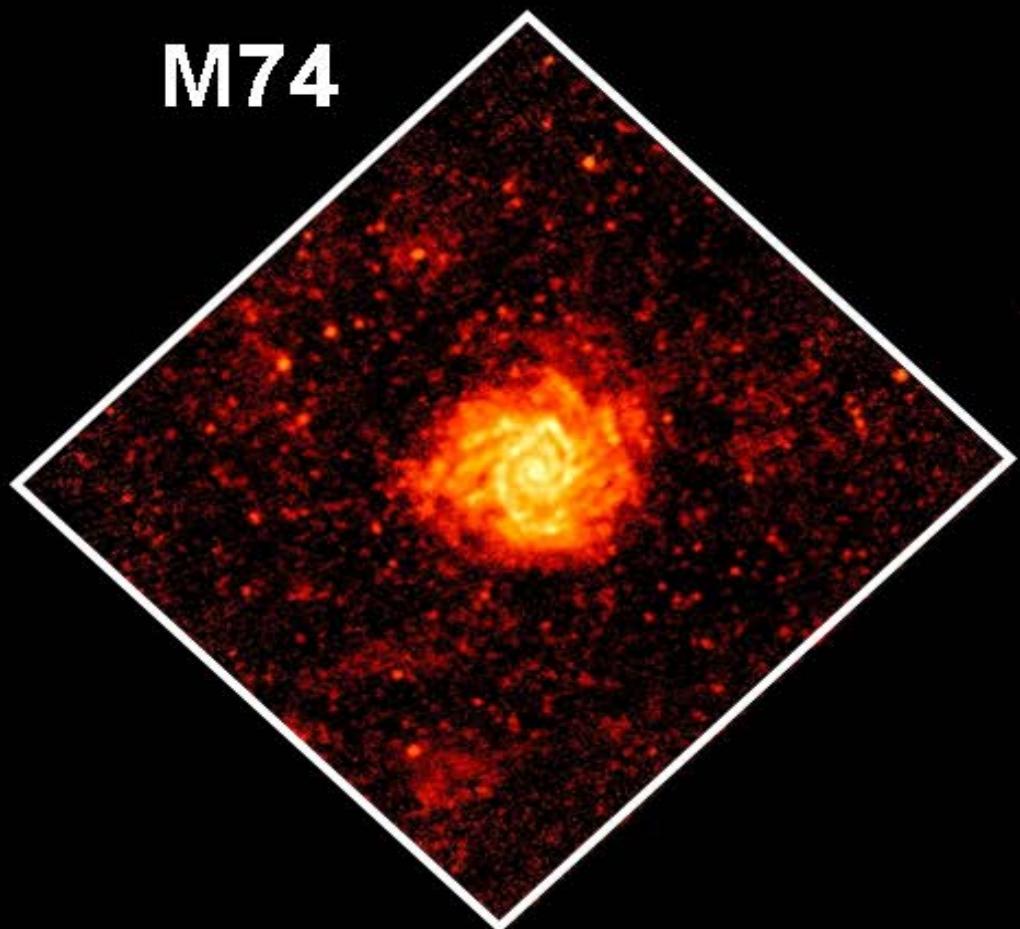
Antennula Galaxy: ESO/PACS & SPIRE Consortium, O. Krause, H.C. H. Linz,

Herschel/SPIRE 250 μ m Images

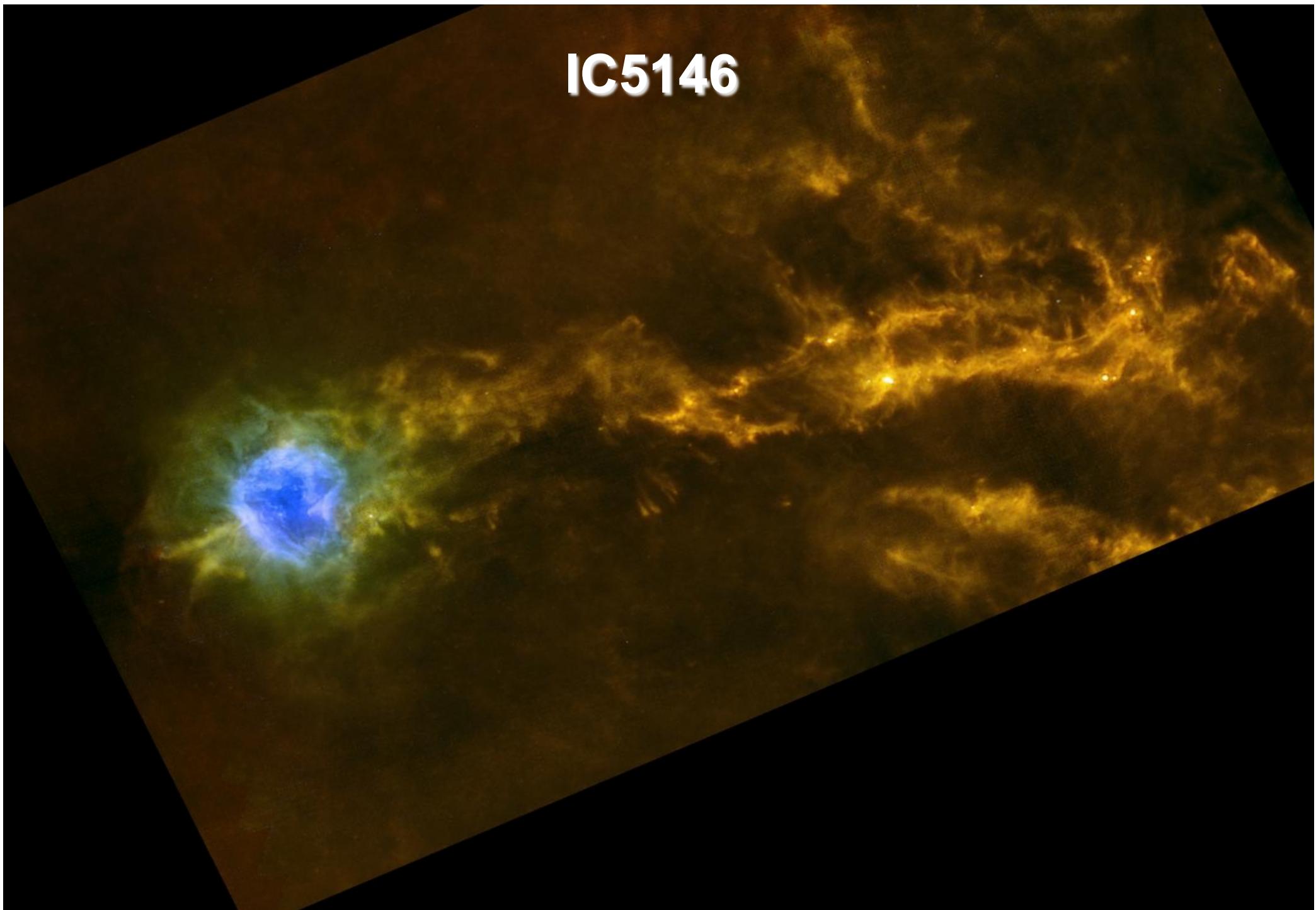
M66



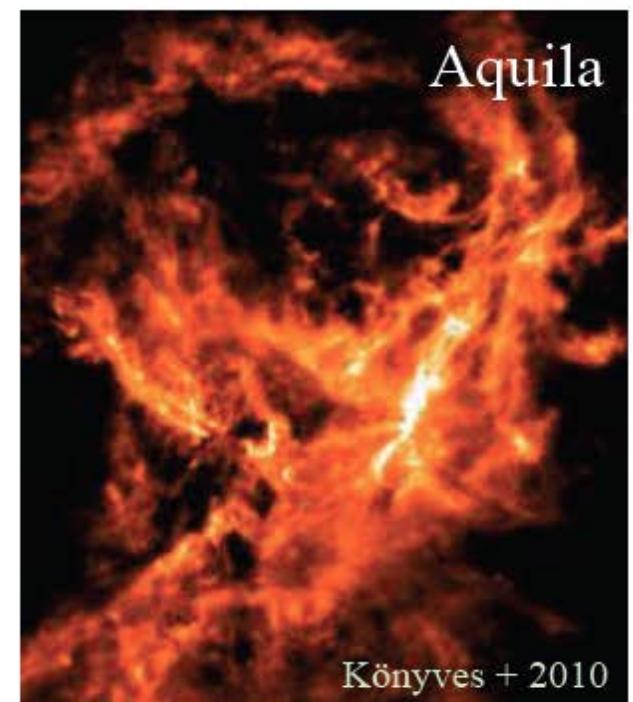
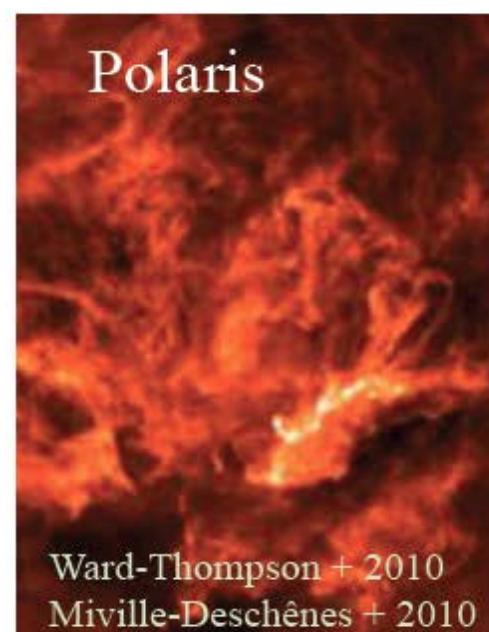
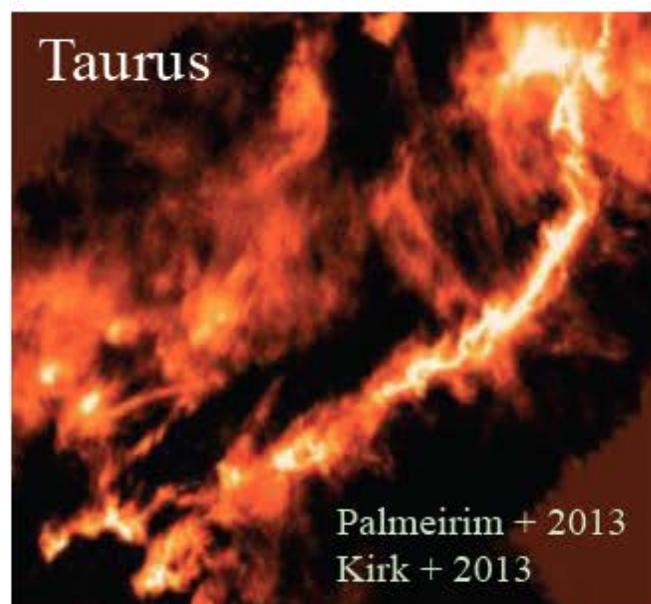
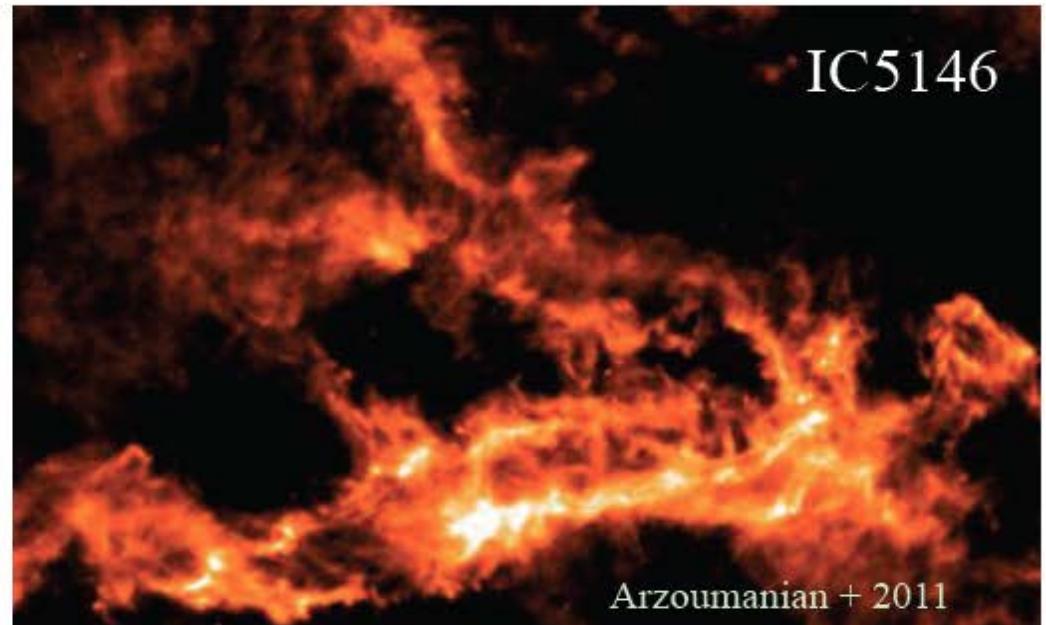
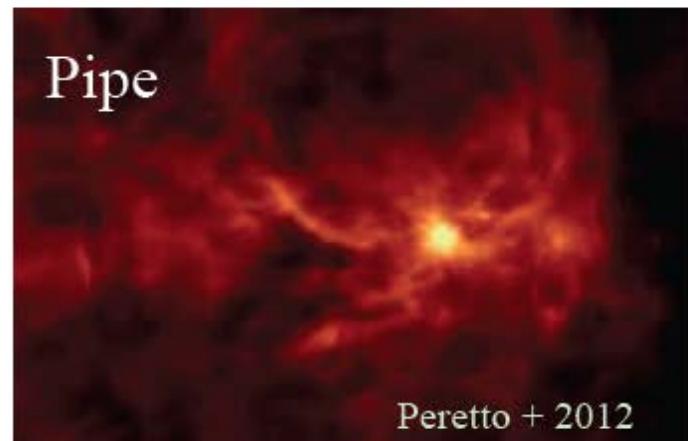
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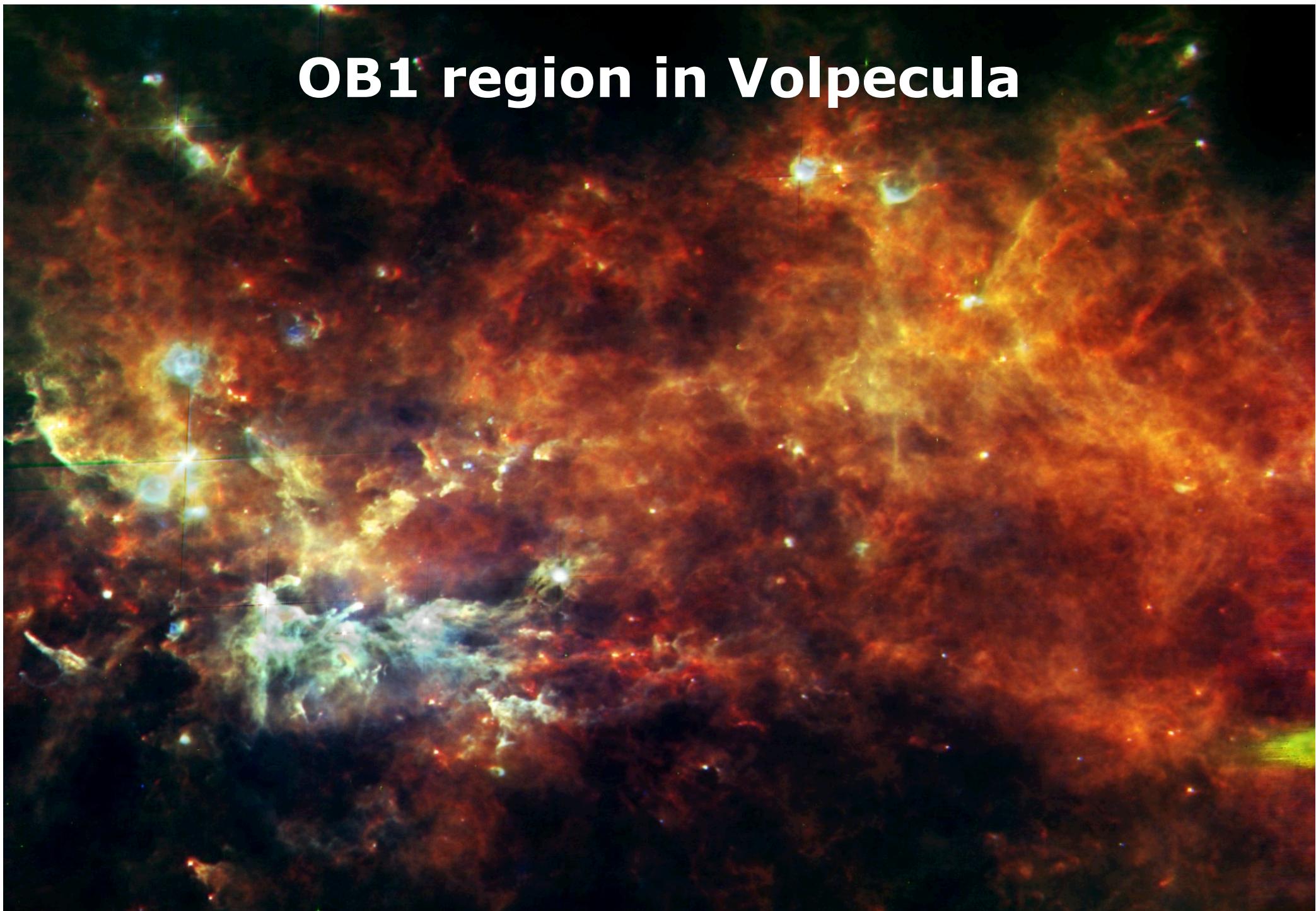
IC5146



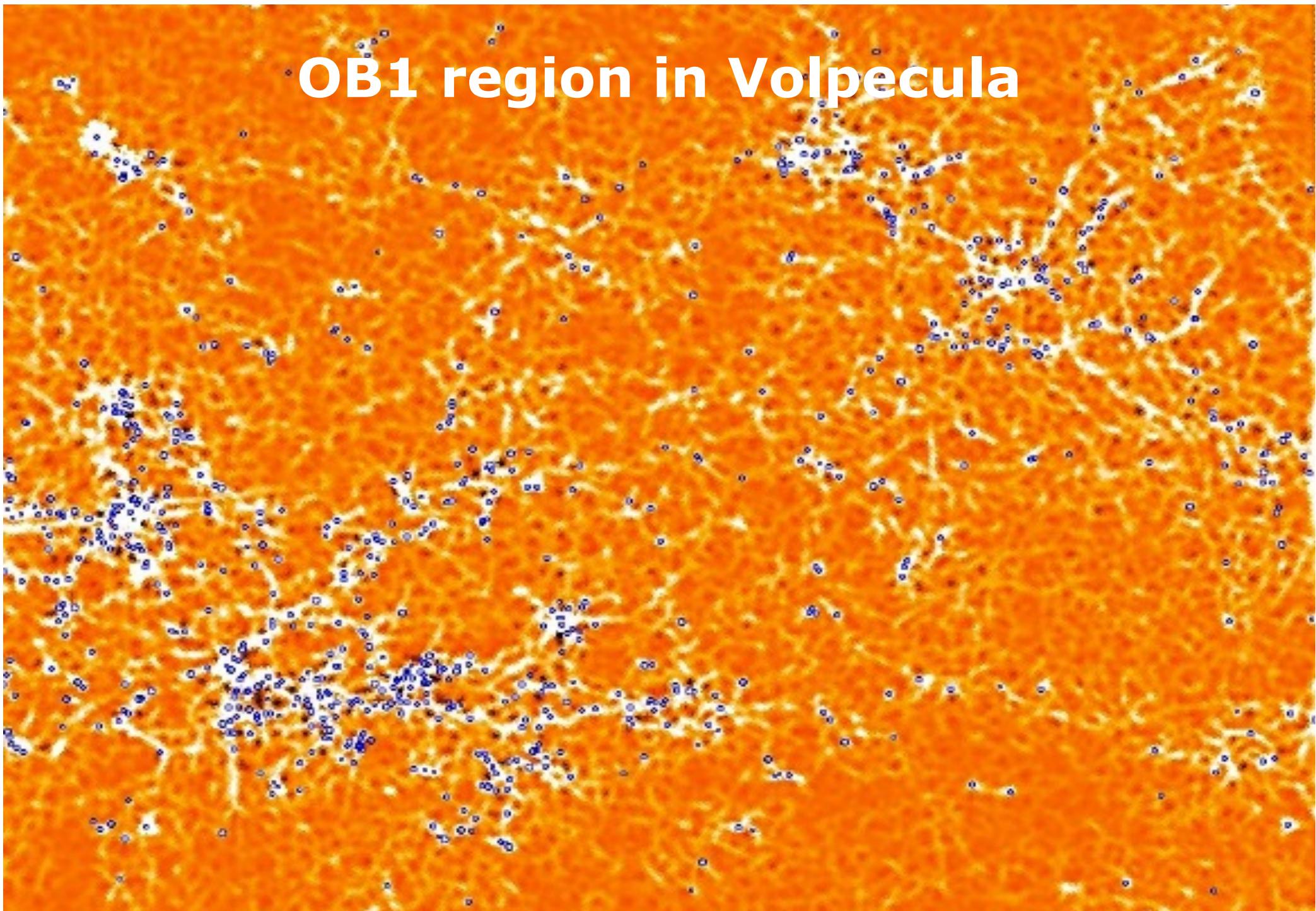
Herschel reveals
a “universal” filamentary
structure in the cold ISM

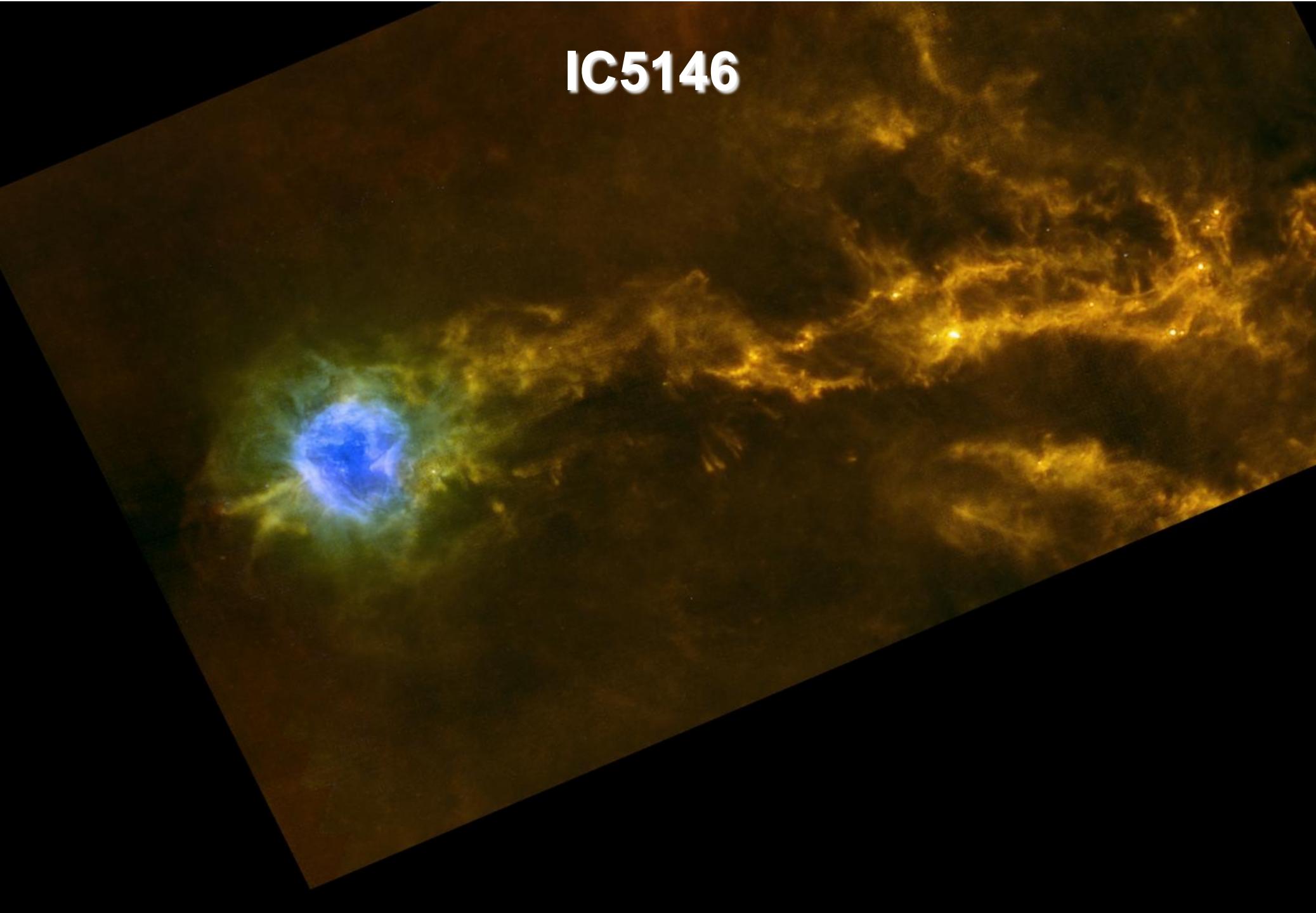


OB1 region in Volpecula



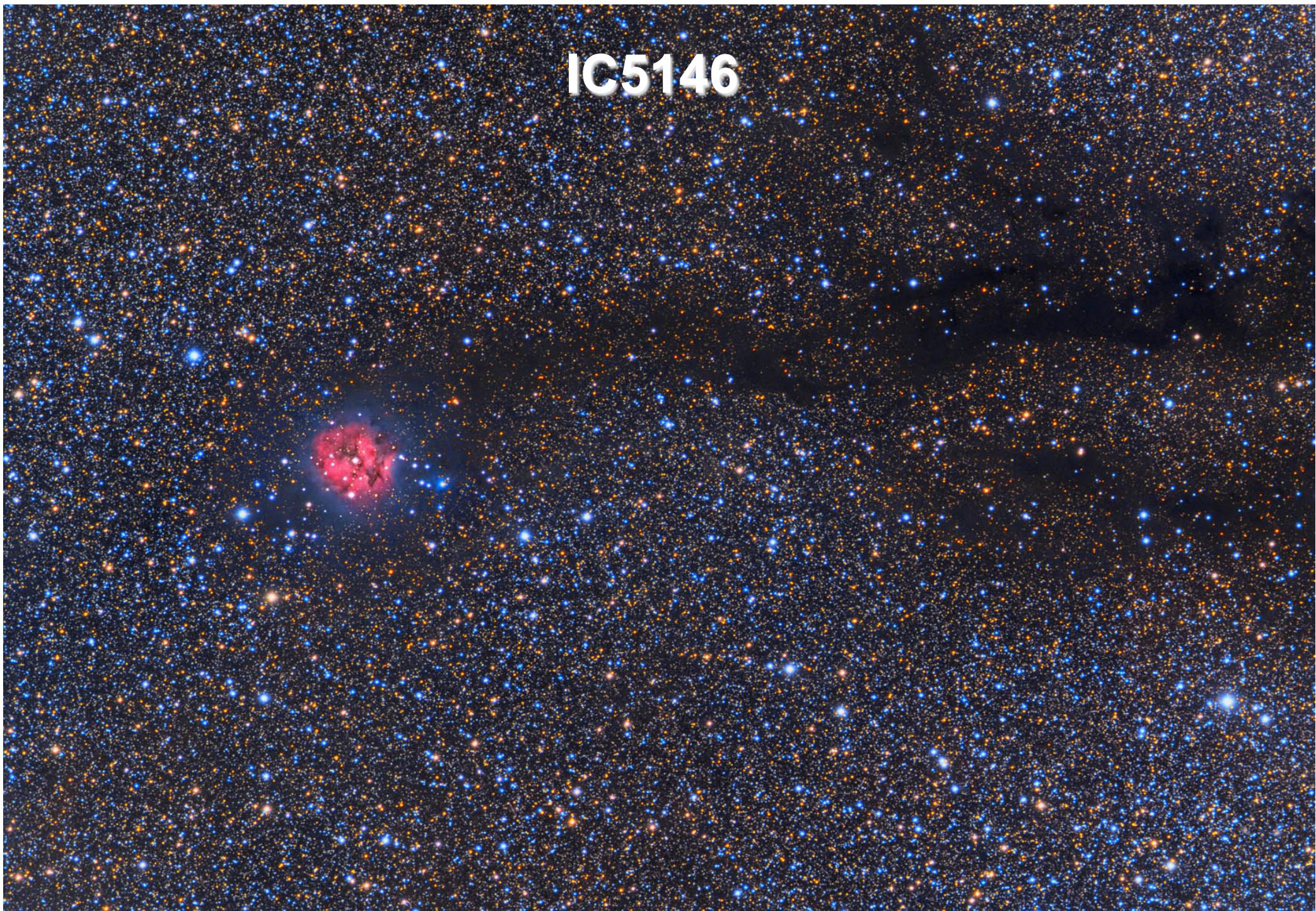
OB1 region in Volpecula



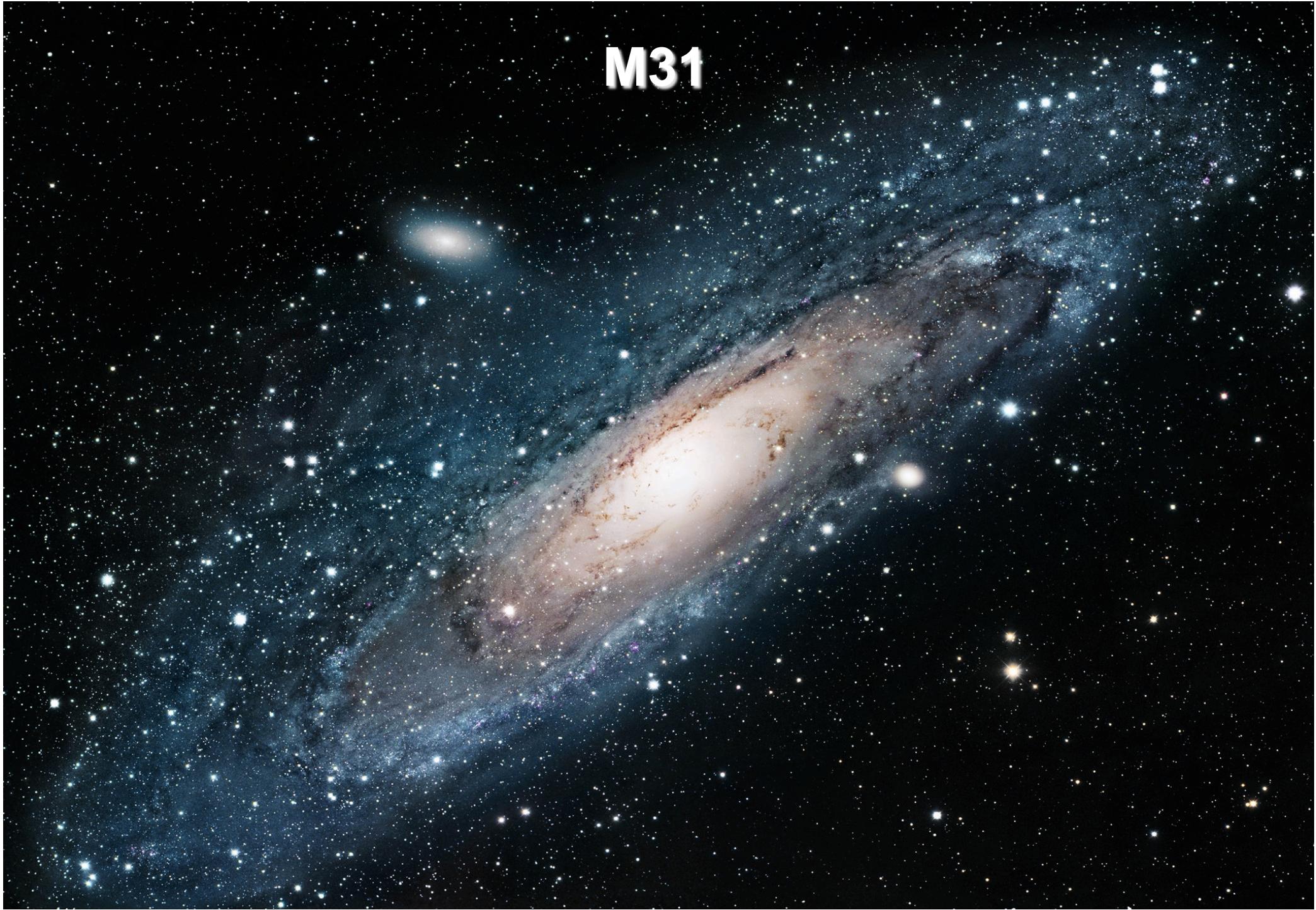


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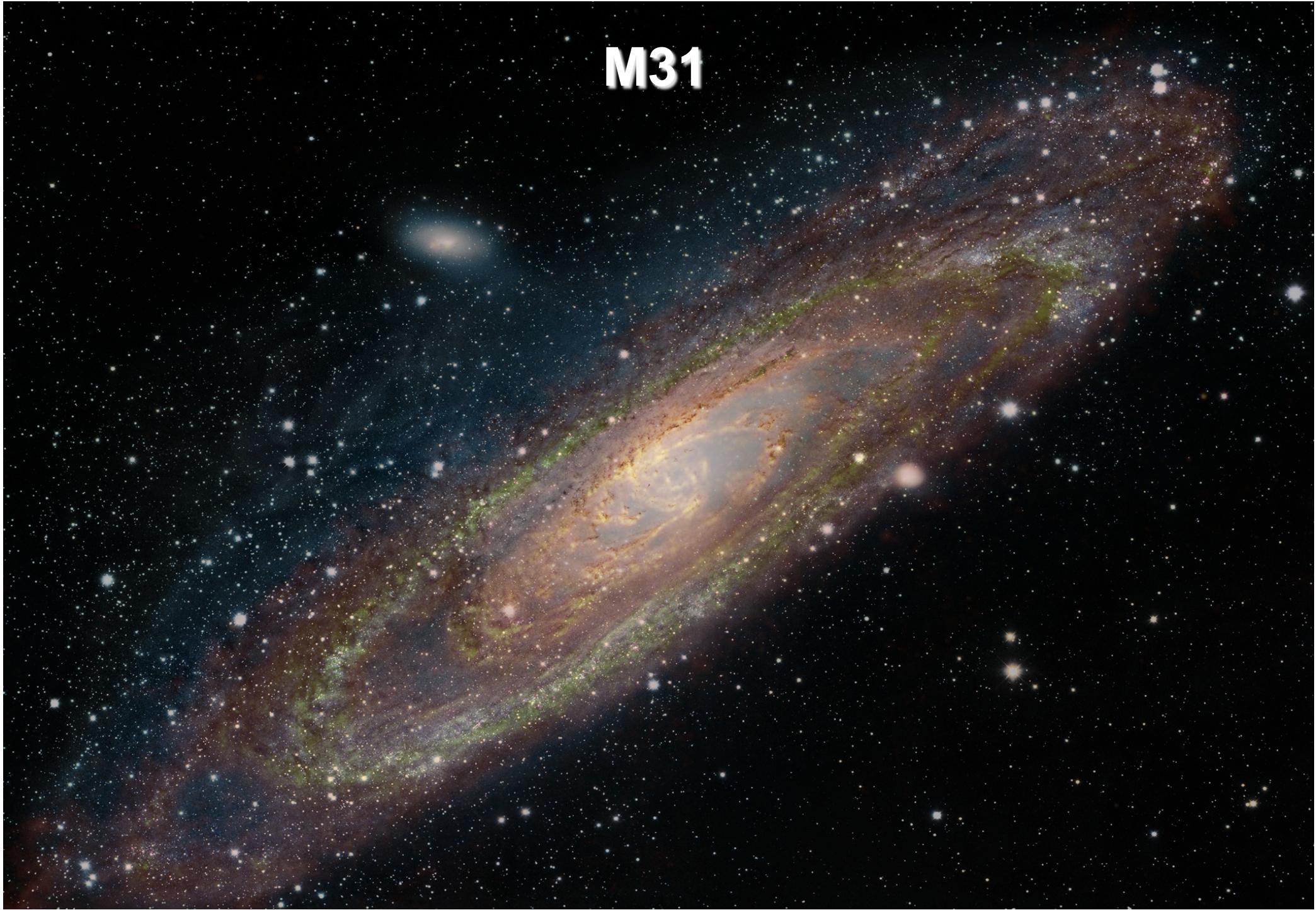
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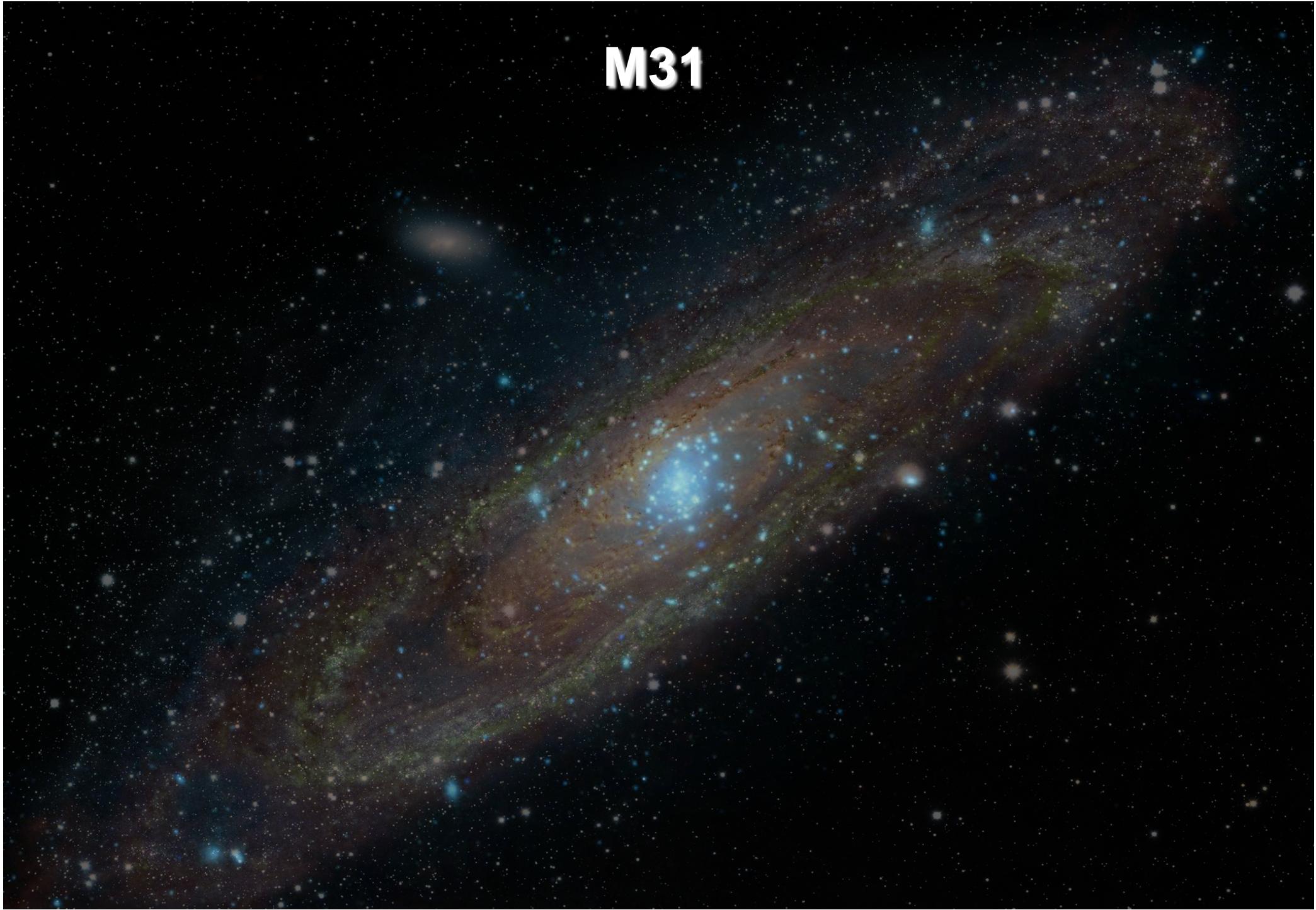
M31



M31



M31

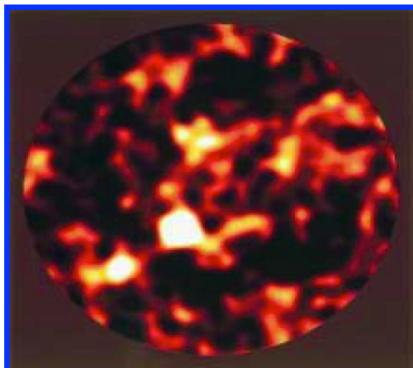


Progress in submm observations

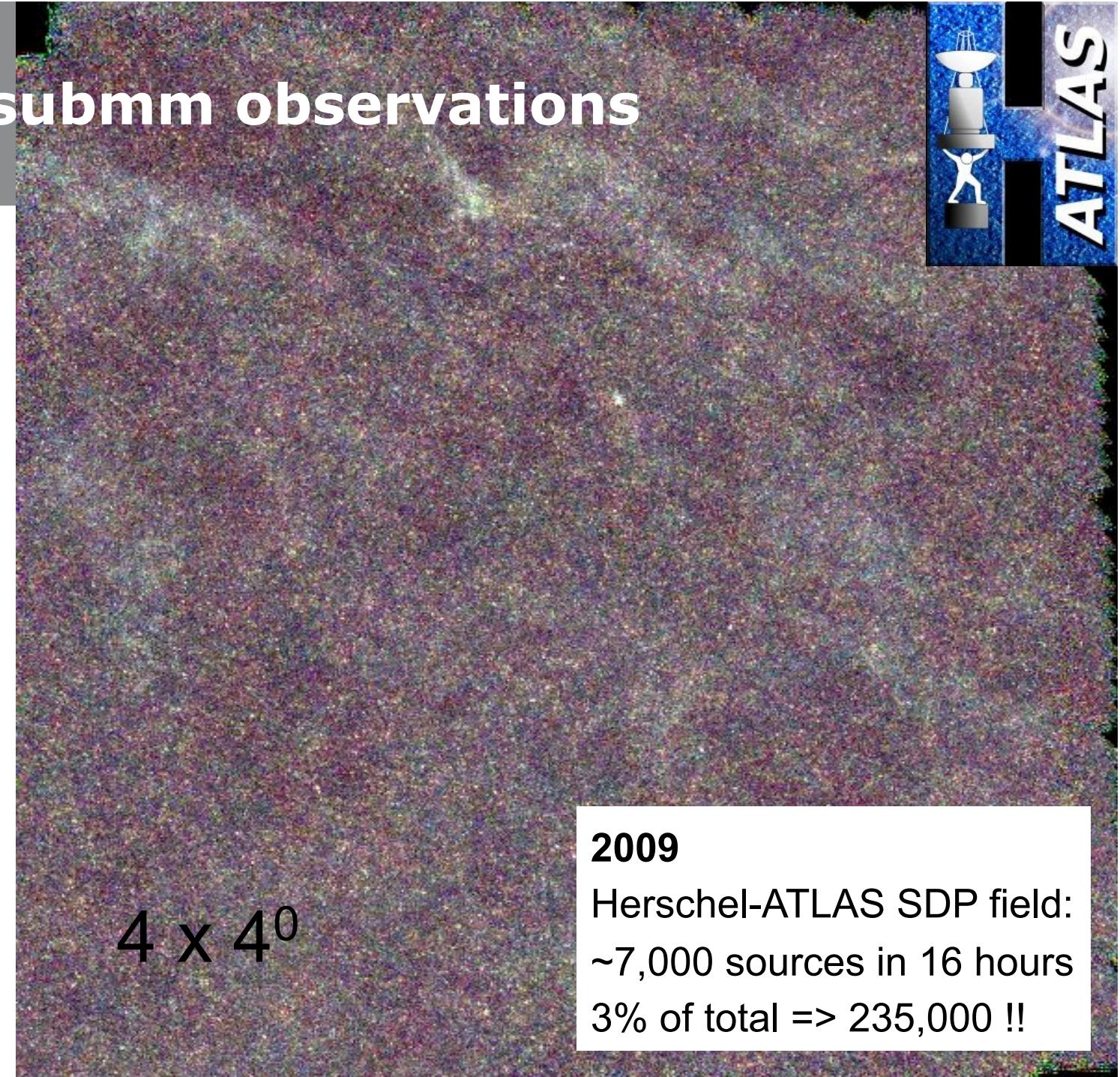


1998

SCUBA HDF:
5 sources after 20
exceptional nights



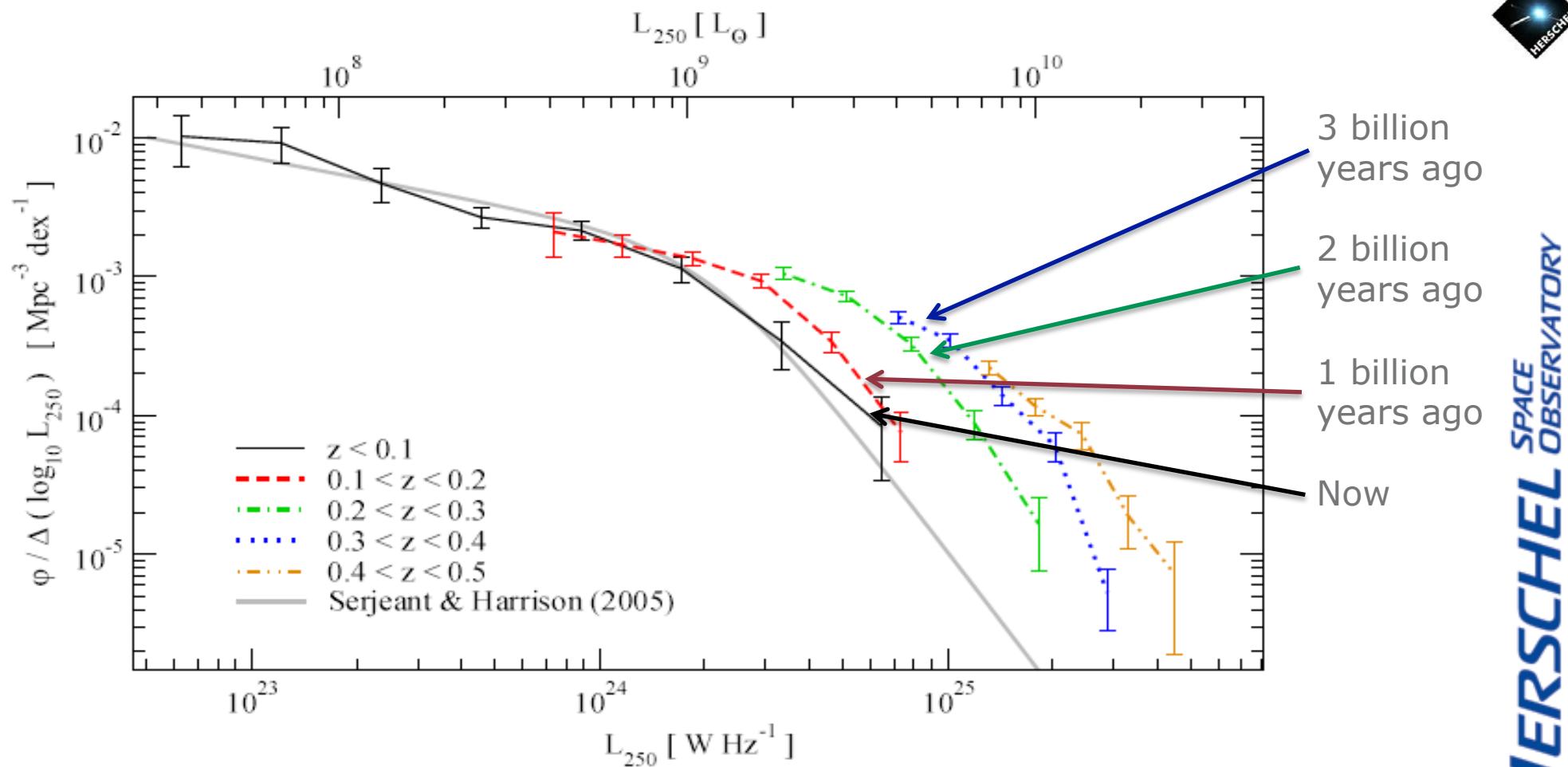
~3 arcmin



2009

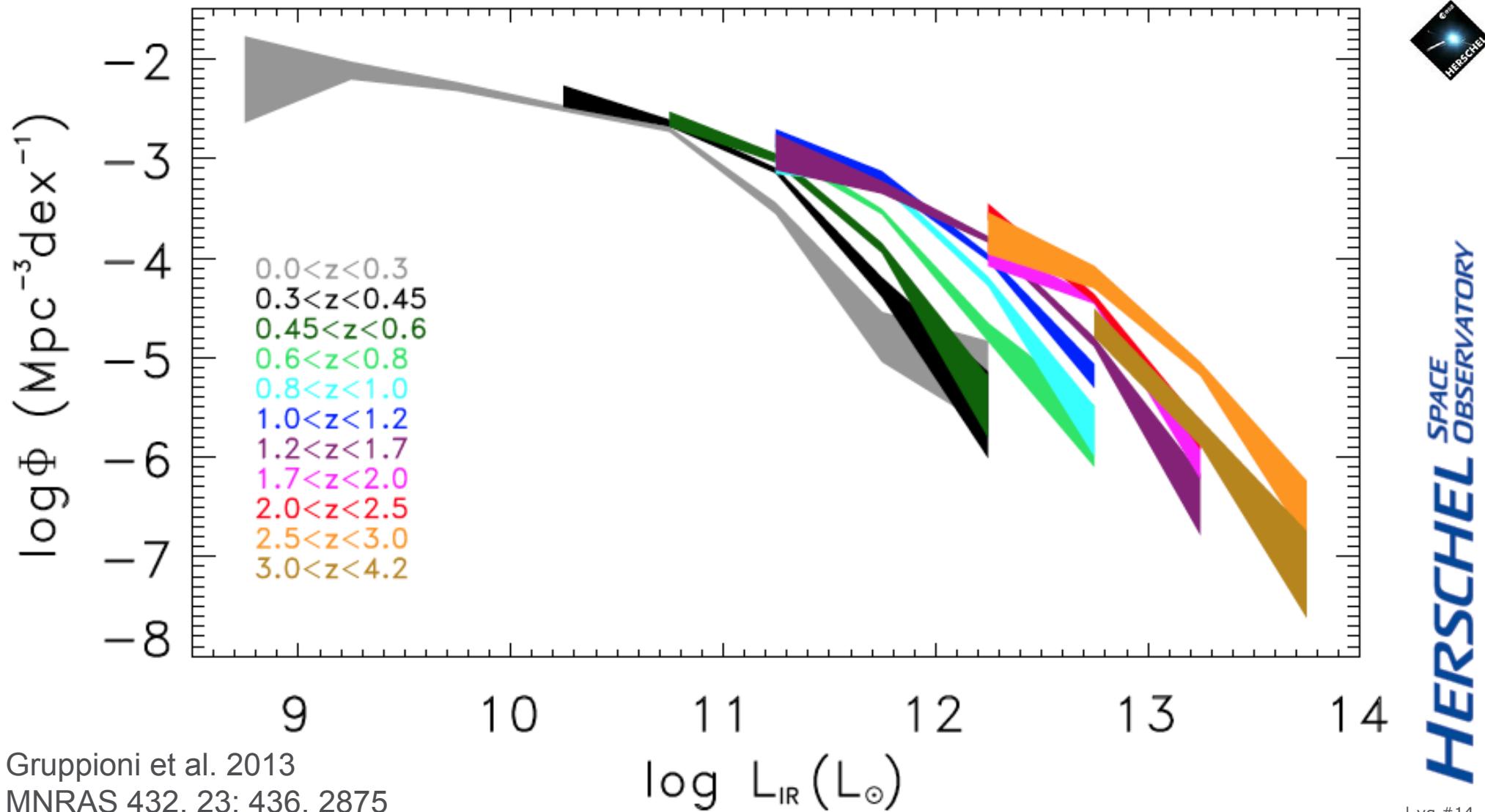
Herschel-ATLAS SDP field:
~7,000 sources in 16 hours
3% of total => 235,000 !!

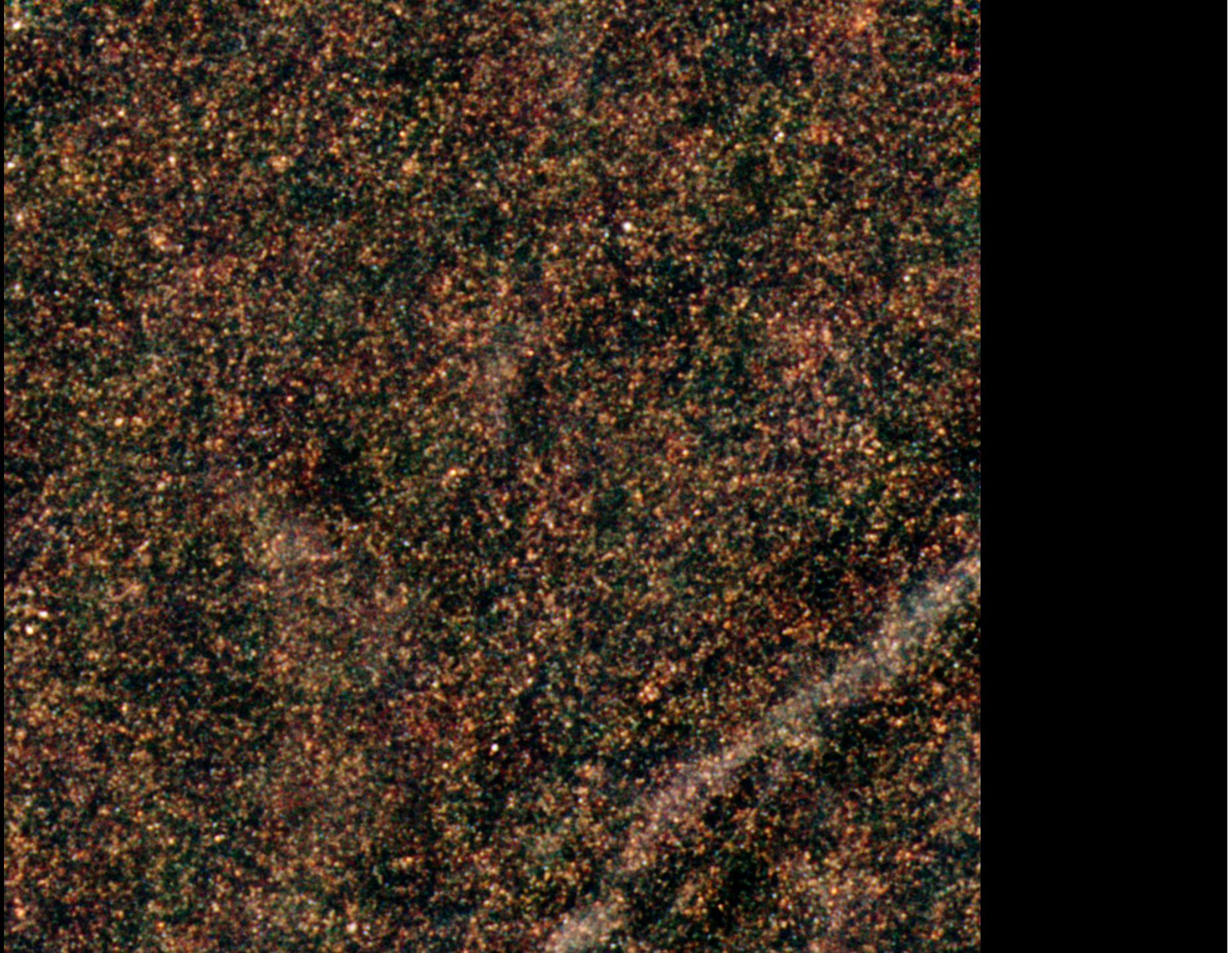
Evolution of the 250 μ m Luminosity Function

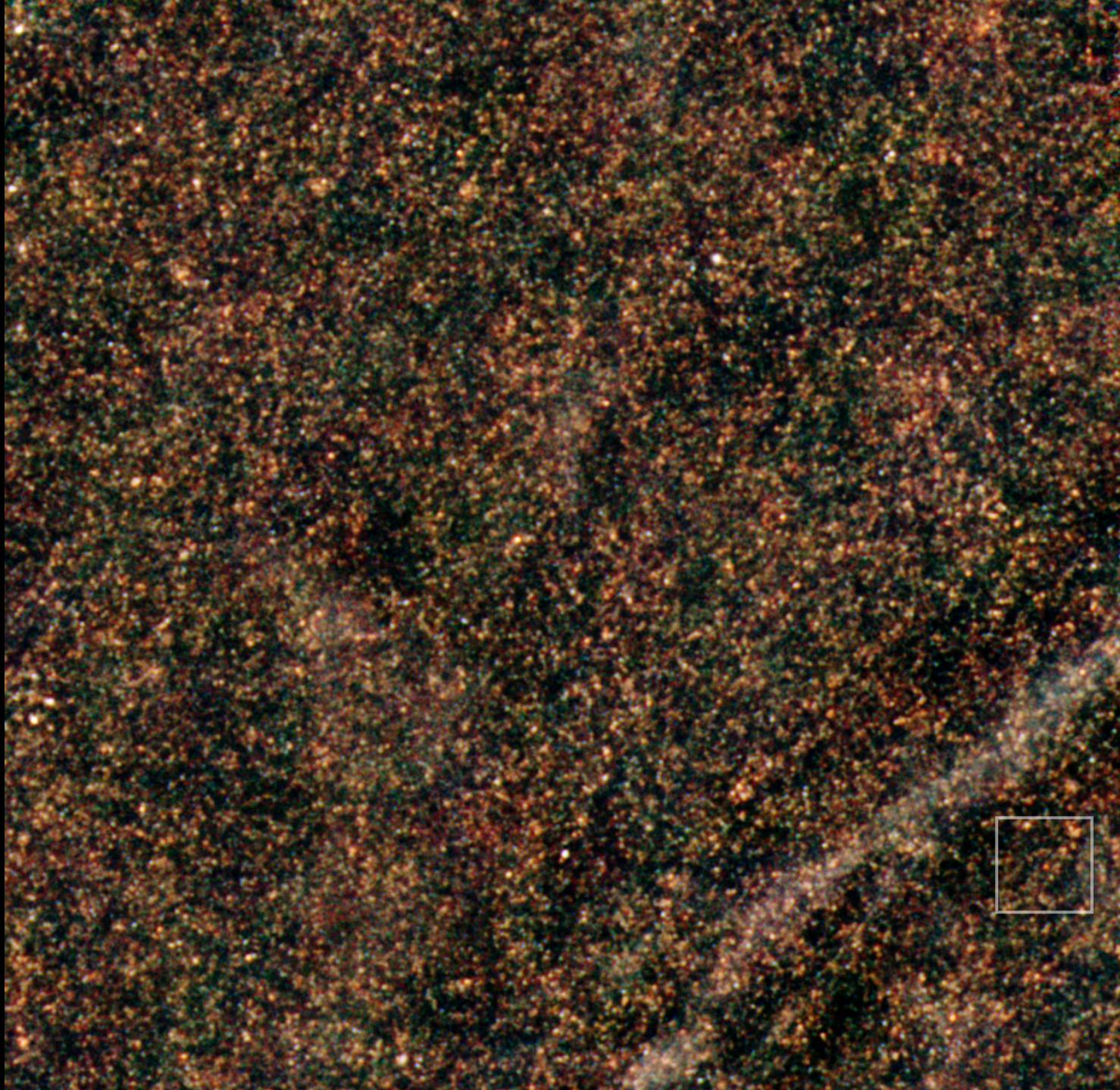


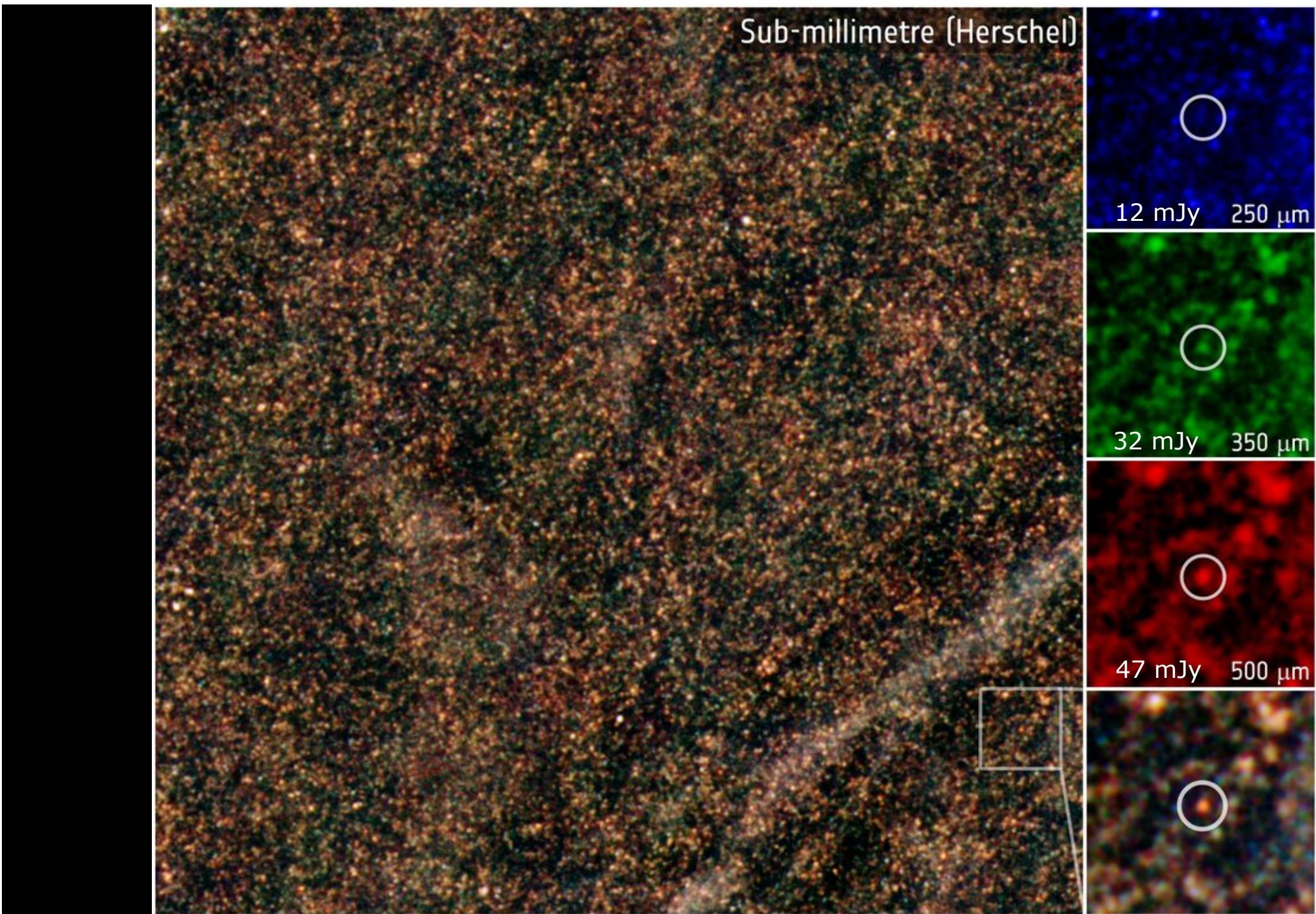
Dye et al. 2010
A&A 518, L10 (Special Issue)

Total IR LF from four PEP fields









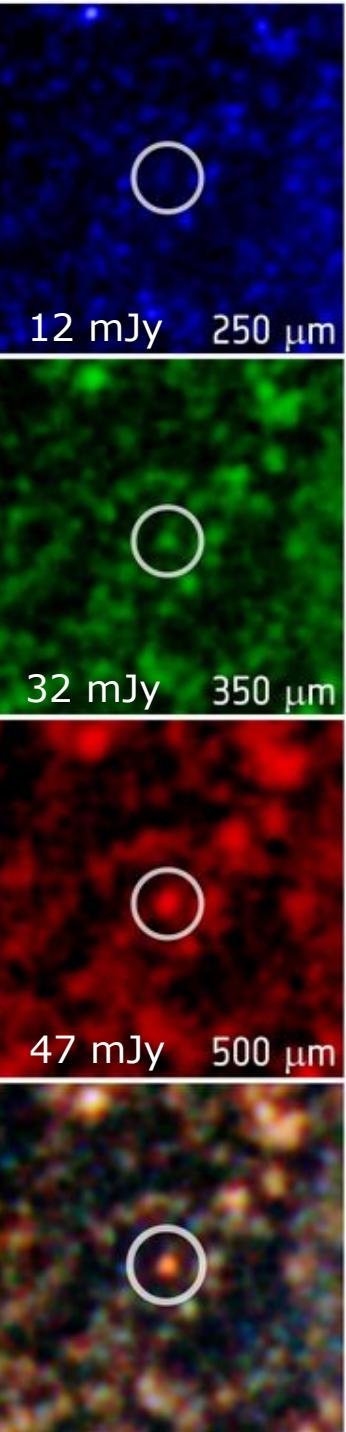
Sub-millimetre (Herschel)

HFLS3: a super-starburst at z=6.34

- **SFR $\sim 2900 M_{\text{sun}}/\text{yr}$** (1000-5000 dep on IMF)
- **$\sim 880 \text{ Myr}$ after the Big Bang**
- **A challenge for galaxy formation theories**

• L_{FIR}	$\sim 16^* \text{A220}$	&	$\sim 2600^* \text{MW}$
• SFR	$\sim 16^* \text{A220}$	&	$\sim 2200^* \text{MW}$
• M_{star}	$\sim 1^* \text{A220}$	&	$\sim 0.5^* \text{MW}$
• M_{gas}	$\sim 20^* \text{A220}$	&	$\sim 40^* \text{MW}$
• M_{dust}	$\sim 13^* \text{A220}$	&	$\sim 22^* \text{MW}$
• $M_{\text{dust}}/M_{\text{gas}}$	$\sim 0.6^* \text{A220}$	&	$\sim 0.5^* \text{MW}$

	HFLS 3	Arp 220*	Milky Way*
z	6.3369	0.0181	
$M_{\text{gas}} (M_{\text{sun}})^\dagger$	$(1.04 \pm 0.09) \times 10^{11}$	5.2×10^9	2.5×10^9
$M_{\text{dust}} (M_{\text{sun}})^\ddagger$	$1.31_{-0.30}^{+0.32} \times 10^9$	$\sim 1 \times 10^8$	$\sim 6 \times 10^7$
$M_*(M_{\text{sun}})^\S$	$\sim 3.7 \times 10^{10}$	$\sim (3-5) \times 10^{10}$	$\sim 6.4 \times 10^{10}$
$M_{\text{dyn}} (M_{\text{sun}})^\S$	2.7×10^{11}	3.45×10^{10}	$2 \times 10^{11} (< 20 \text{ kpc})$
$f_{\text{gas}} (\%)^\ \mathbb{I}$	40	15	1.2
$L_{\text{FIR}} (L_{\text{sun}})^\#$	$2.86_{-0.31}^{+0.32} \times 10^{13}$	1.8×10^{12}	1.1×10^{10}
$\text{SFR} (M_{\text{sun}} \text{ yr}^{-1})^\star$	2,900	~ 180	1.3
$T_{\text{dust}} (\text{K})^{**}$	$55.9_{-12.0}^{+9.3}$	66	~ 19





HFLS3 extreme but not unique!

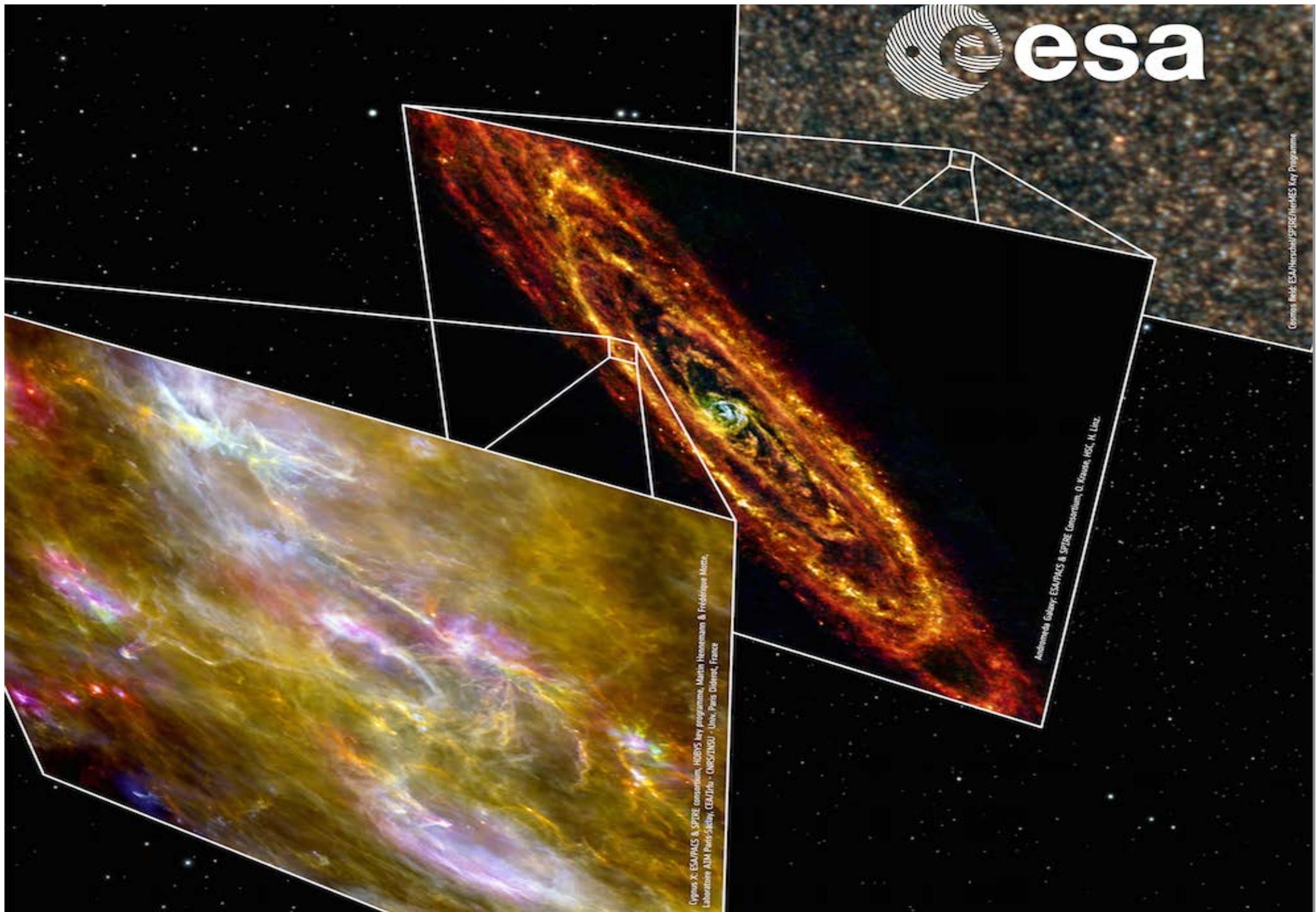
- ‘Red’ SPIRE sources in HerMES SDP fields
- HFLS3 was an initial success
- 38 candidates in 21 deg^2 – 4 out 5 studied have $z > 4$
- Estimated source density of $z > 4$ sources $\sim 2 \text{ deg}^{-2}$
- Much higher than predicted by current galaxy evolution models – population extends to higher z than believed?

Darren Dowell et al. 2014
ApJ 780, 75



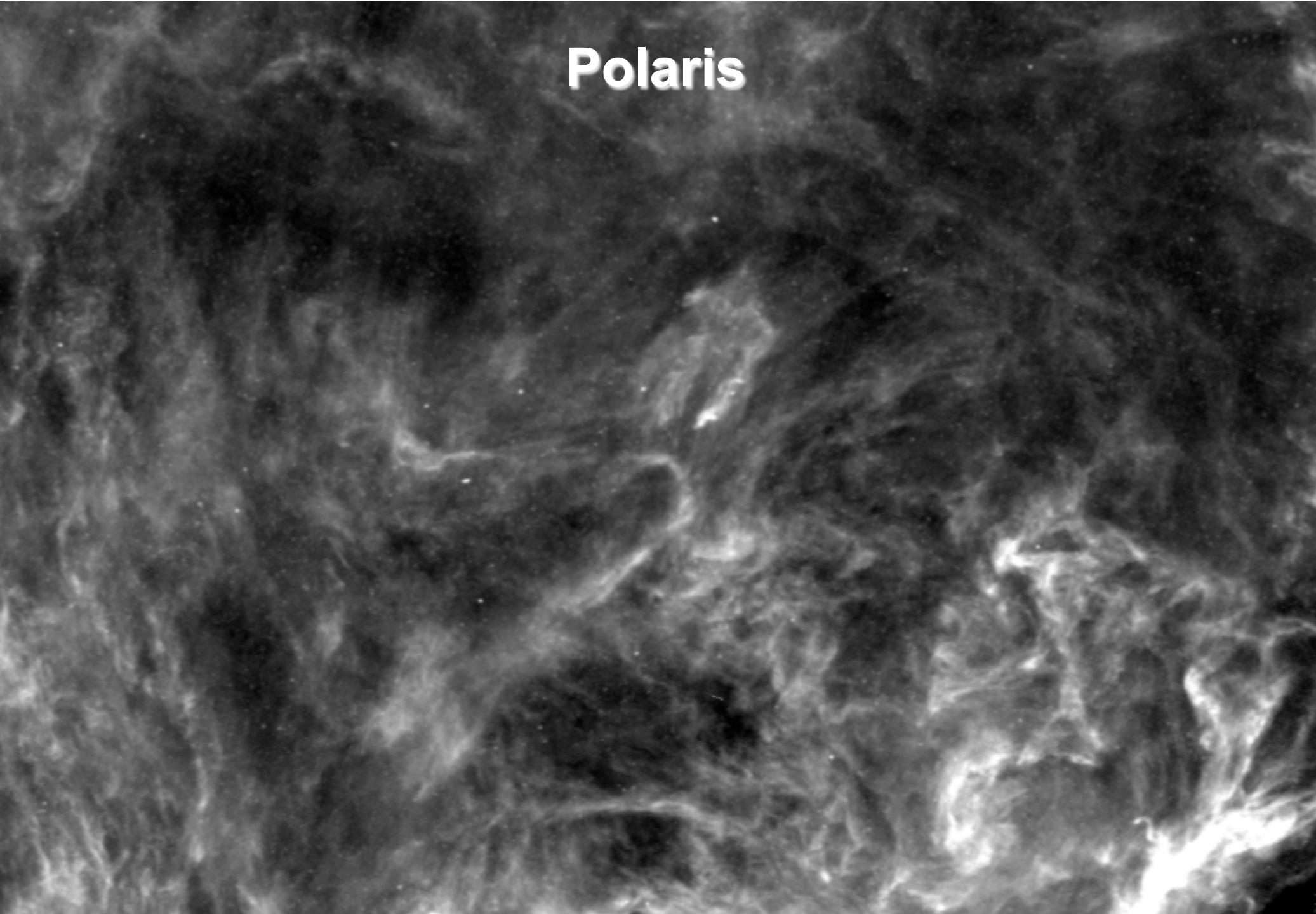
esa

Credit: Hubble/SPiRE/HOBES Key Programme

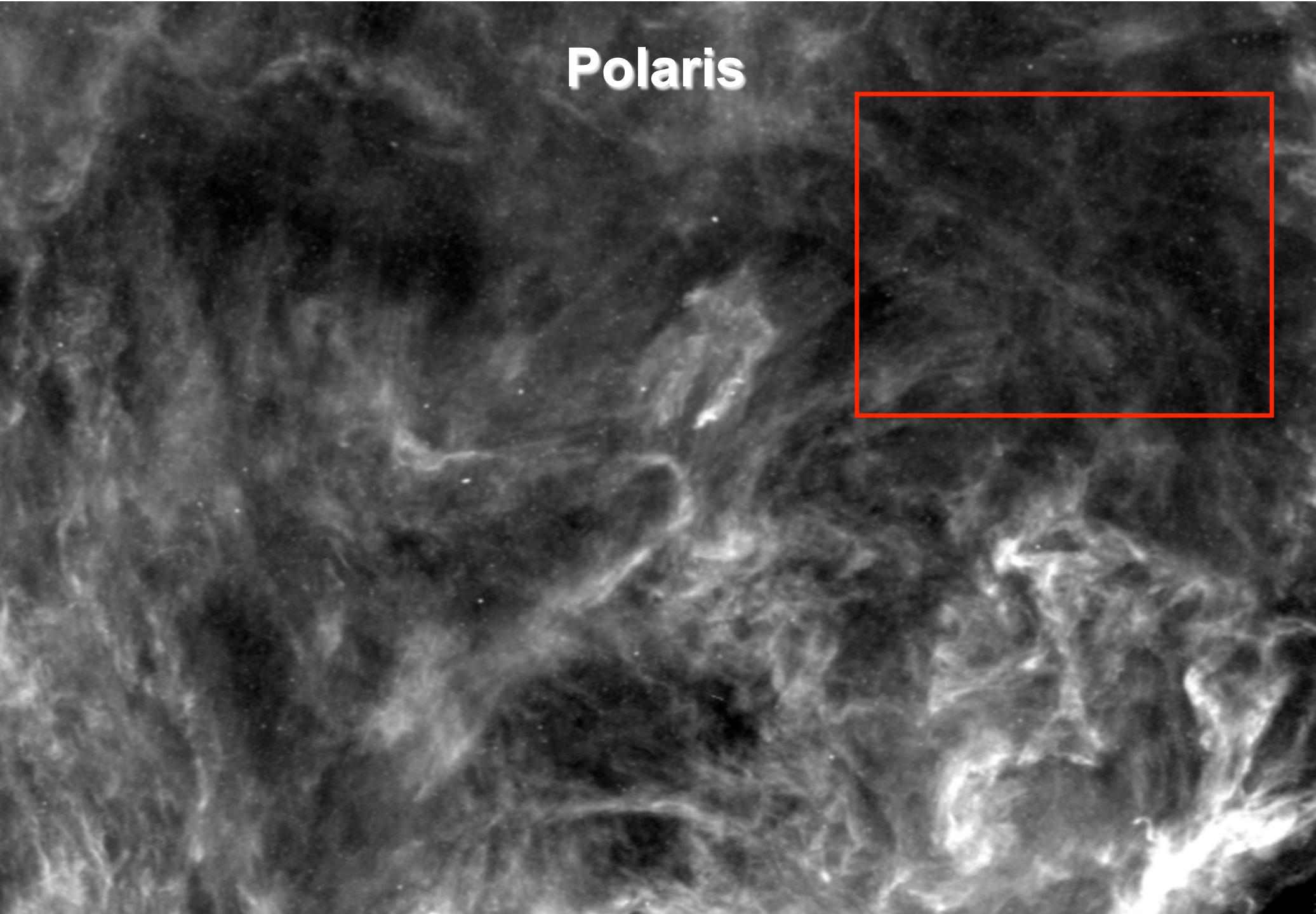


Ogasawara, ESO/PACS & SPIRE consortium, HOBES key programme, Martin Hemmann & Frédérique Motte,
Laboratoire AIM Paris-Saclay, CEA/IRFU + CNRS/INSU - Univ. Paris Diderot, France

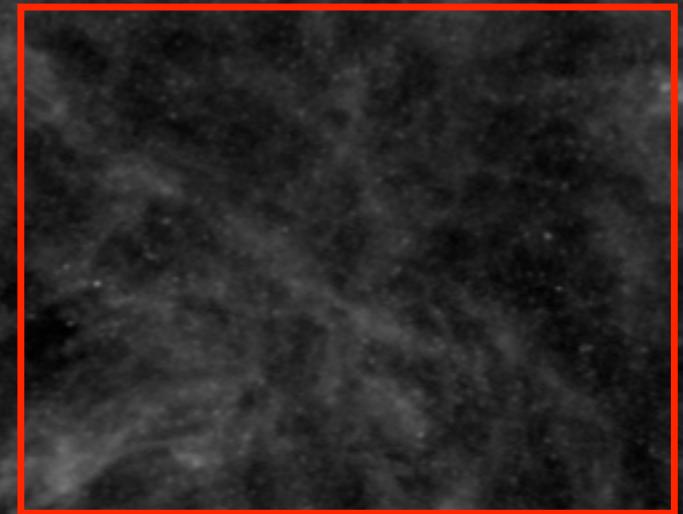
Andromeda Galaxy: ESO/PACS & SPIRE Consortium, O. Krause, HSC, H. Linz,

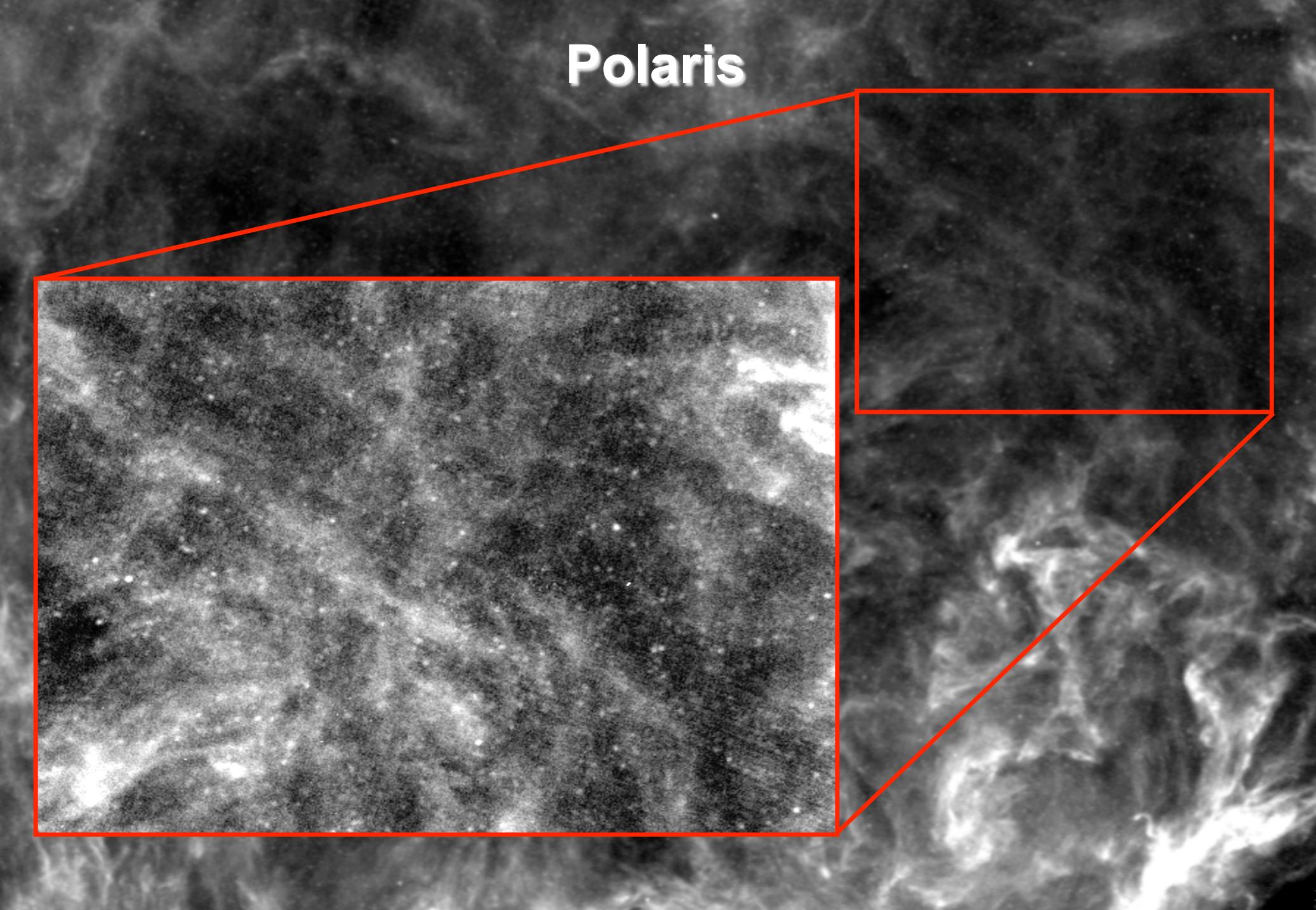


Polaris



Polaris





Polaris



WELCOME !!

Let's have a great meeting!

Oxygen X: ECAPIAS & SPIRE consortium, HOBTS key programme, Martin Haas, Frédéric Courteau, Frédéric Motte,
Laboratoire AIM Paris-Saclay, CEA/IRFU + CNRS/DSU Univ. Paris Diderot, France

Andrea Poglitsch
HOBTS
HOBTS Consortium, O. Krause, HSC, H. Linz,

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