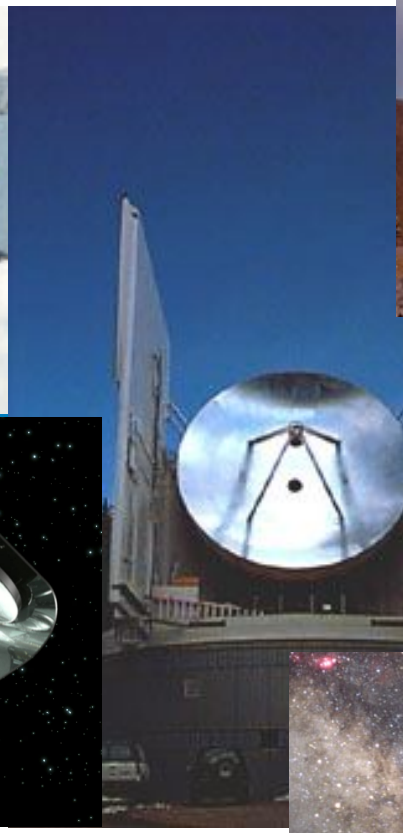
Mapping B-Fields in Star Forming Regions via Dust Emission Polarimetry - *the Polarization Spectrum*

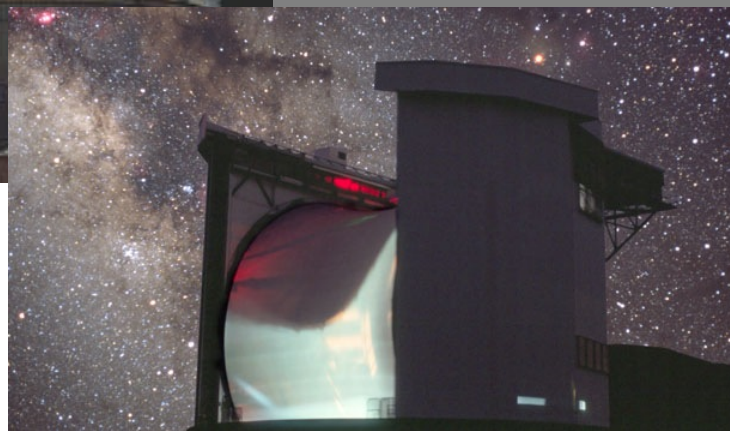
Giles Novak, Northwestern University



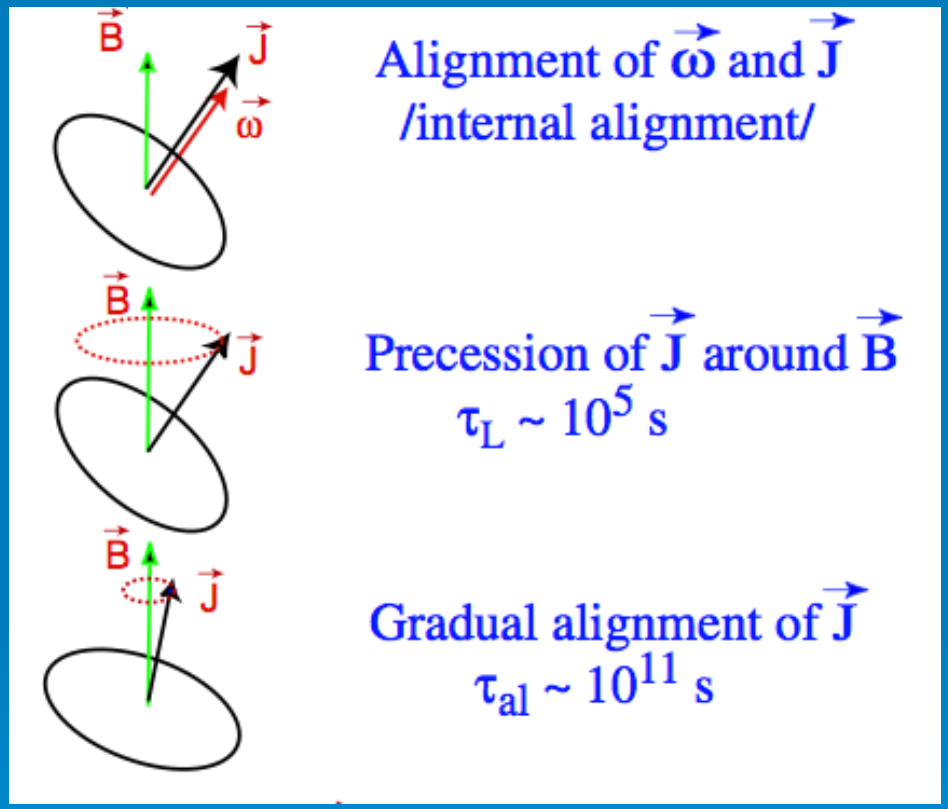
CSO

HHT

JCMT



radiative torques (RATs) – the most promising mechanism for magnetic grain alignment



e.g., Lazarian ’07; Andersson et al. ’15

-- grains must have helicity

-- incident radiation field must be anisotropic

-- grains spin about short axes

-- precession due to μ x B torque enforces *some* kind of alignment with respect to B-field

-- small values of precession cone angle are more stable against RAT *alignment* torques

observational tests of grain alignment theory

size dependence – small grains not aligned
(Kim & Martin ’95)

dependence on A_V – well shielded grains not aligned ?
(Goodman+ ’92, Whittet+ ’08, Alves+ ‘14, Fissel+ ’15)

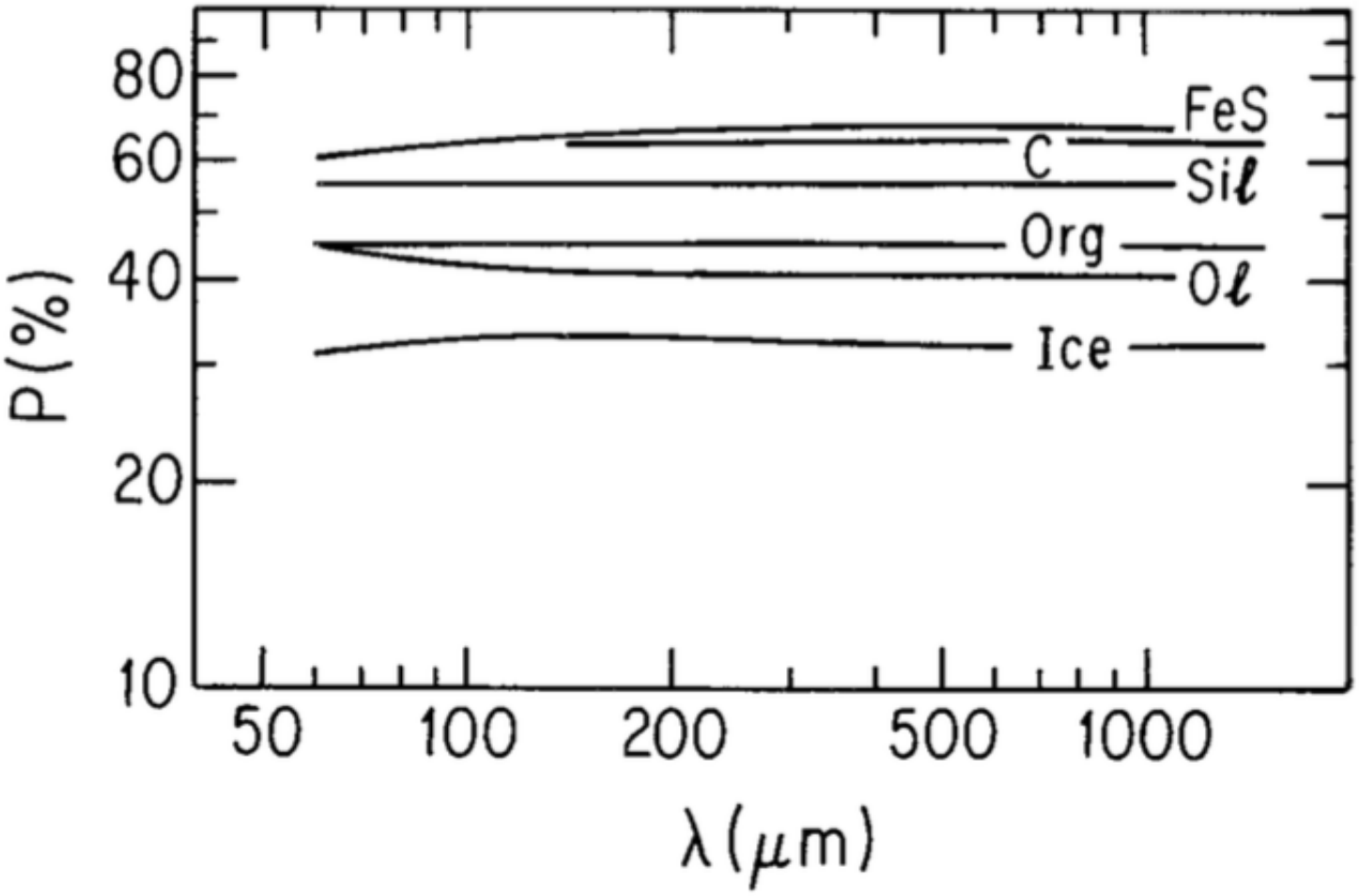
dependence on angle between RAT and B-field
(Andersson+ ’11)

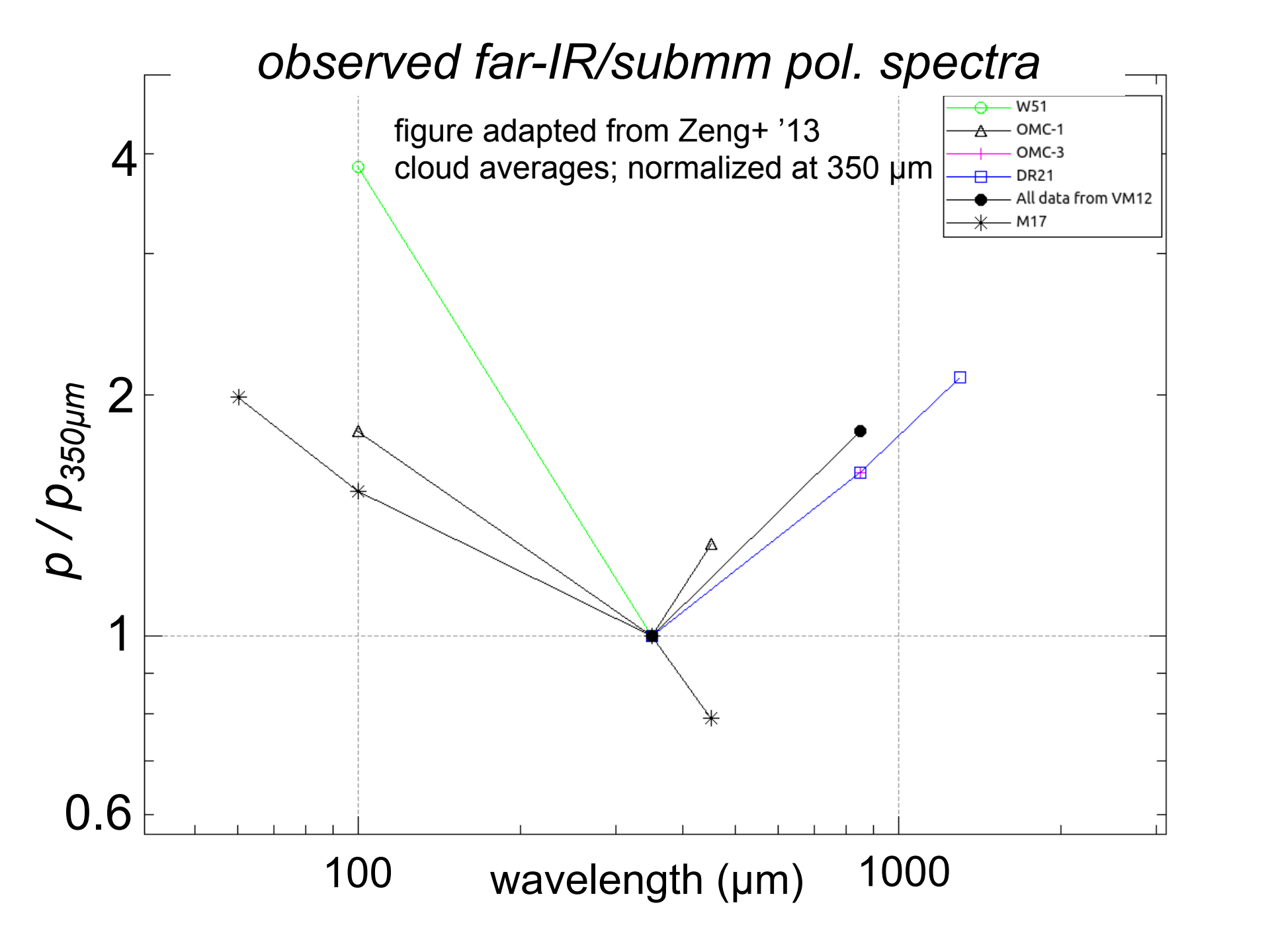
far-IR / submm / mm polarization spectrum
(Hildebrand+ ’99; Zeng+ ’13, *Gandilo+ in prep*.)

(see also Andersson, Lazarian, & Vaillancourt 2015, ARAA)

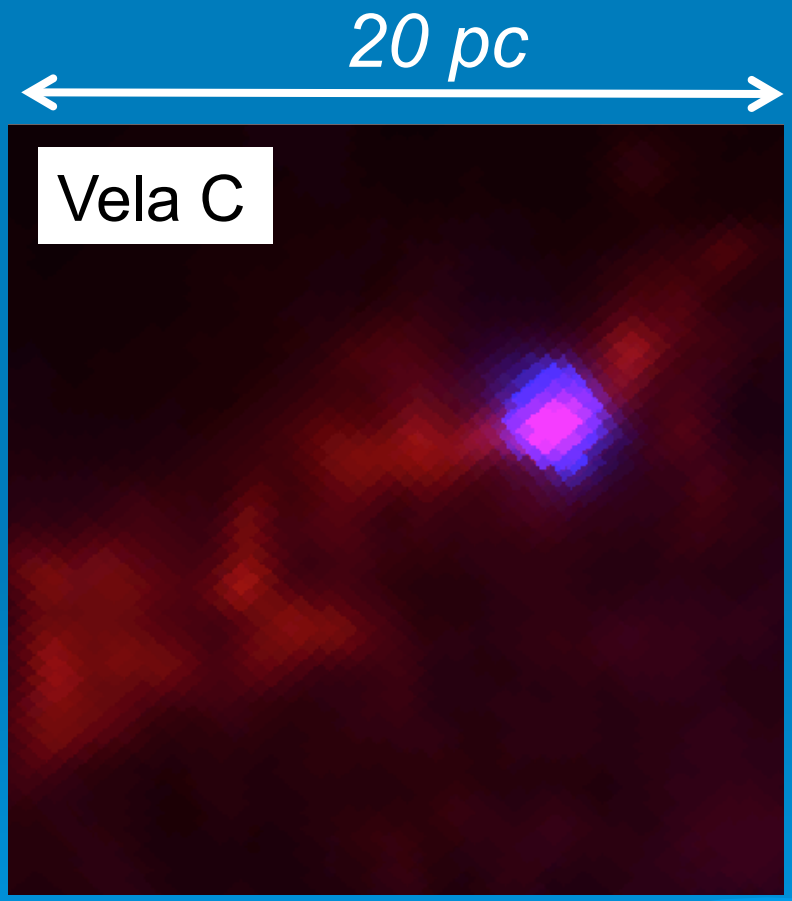
predicted far-IR/submm pol. spectra

Hildebrand+ ’99

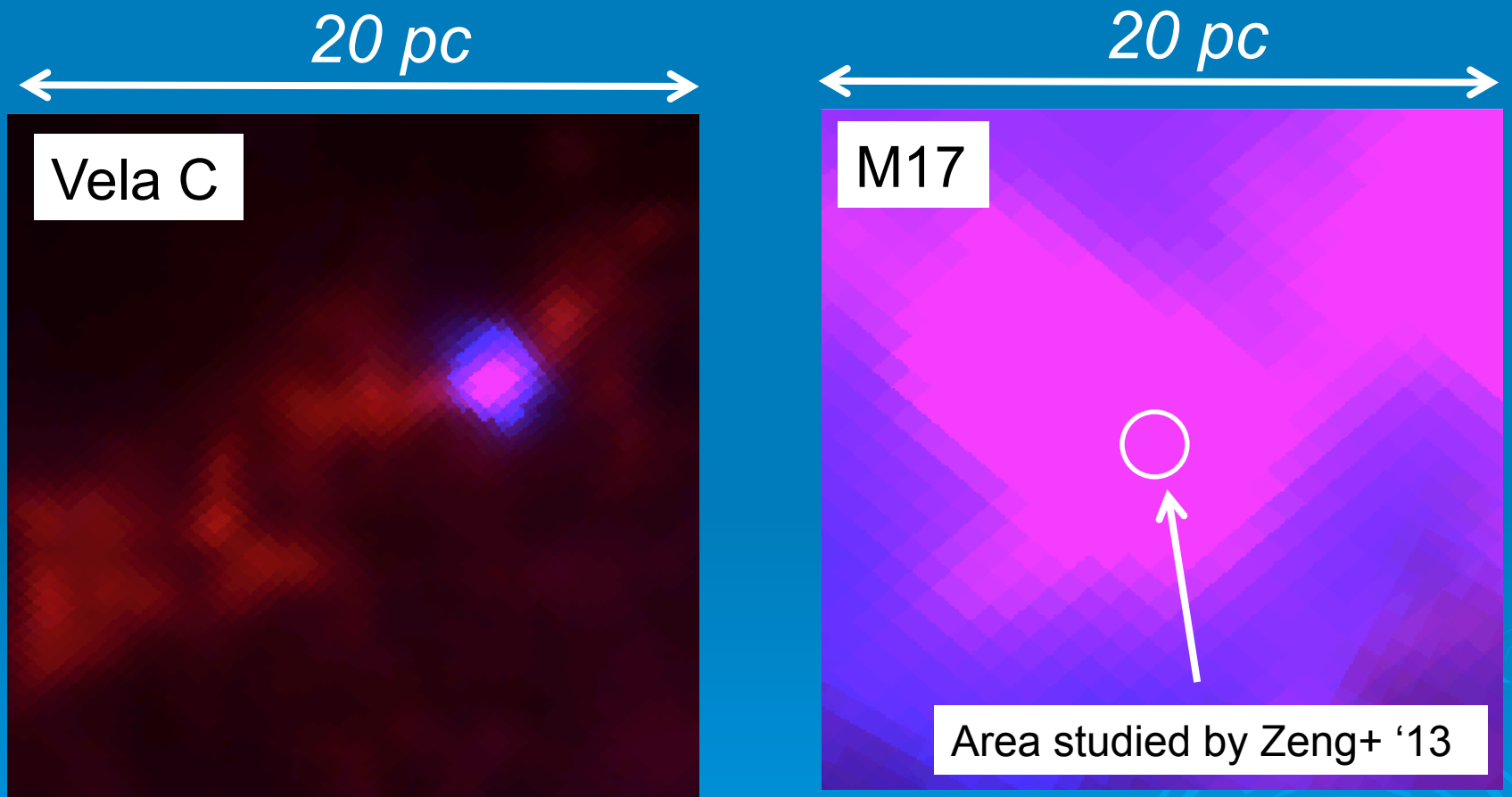



observed far-IR/submm pol. spectra
figure adapted from Zeng+ ’13
cloud averages; normalized at 350 μm
W51
OMC-1
OMC-3
DR21
All data from VM12
M17
p / p350μm
4
2
1
0.6
100
1000
wavelength (μm)

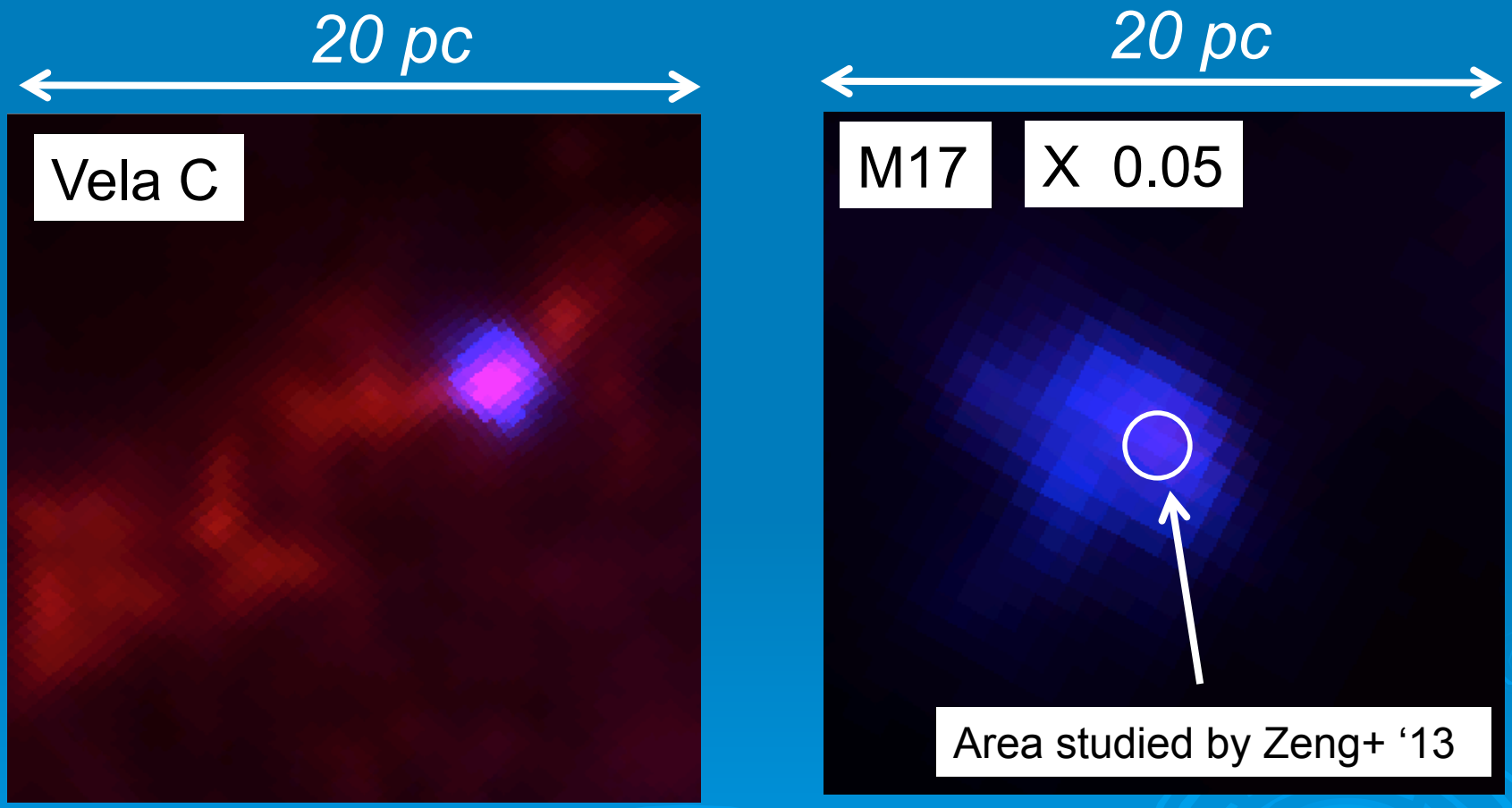
target clouds in *Planck 850 μm* (red) + *IRAS* (blue)



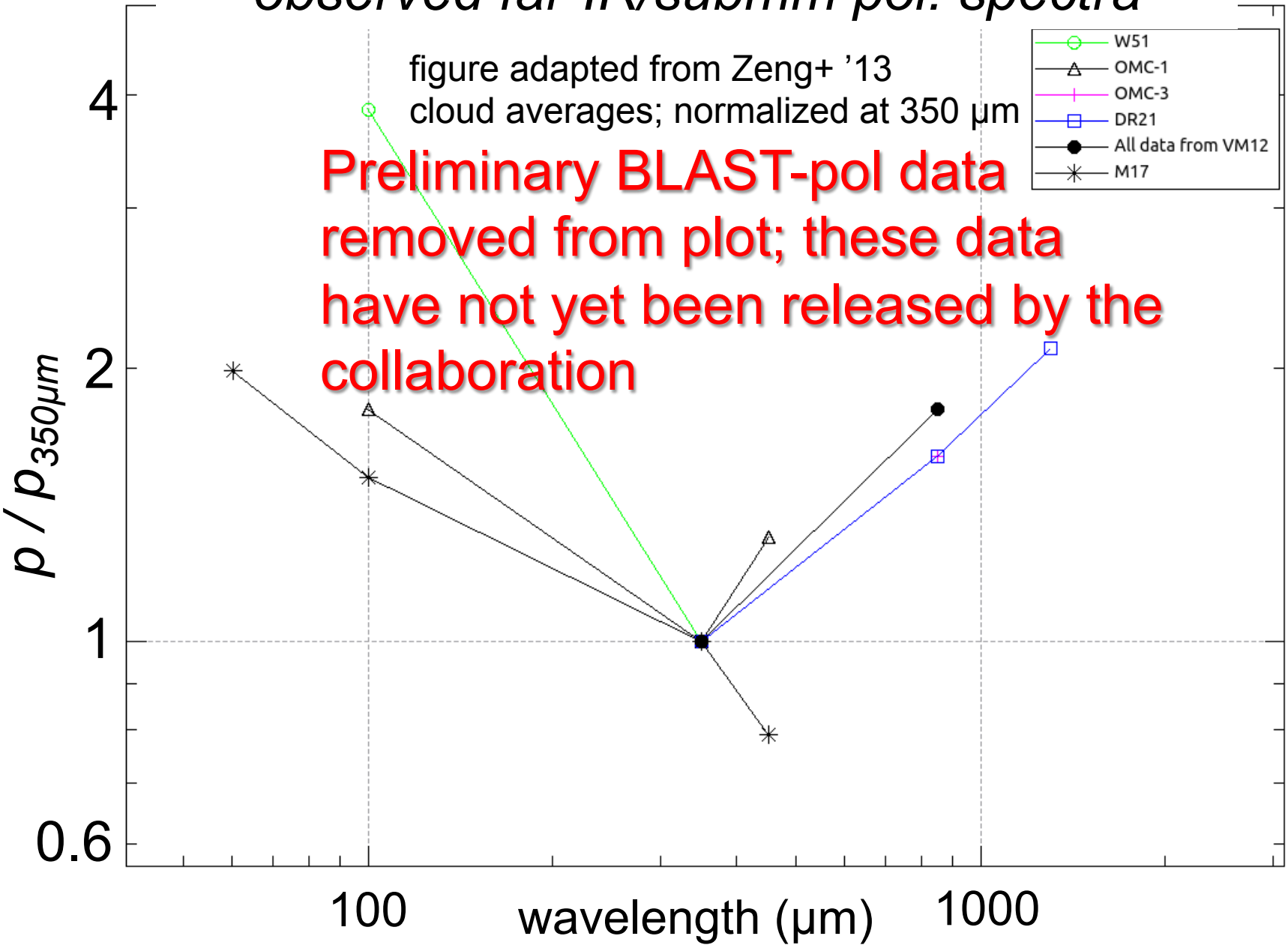
target clouds in *Planck 850 μm* (red) + *IRAS* (blue)

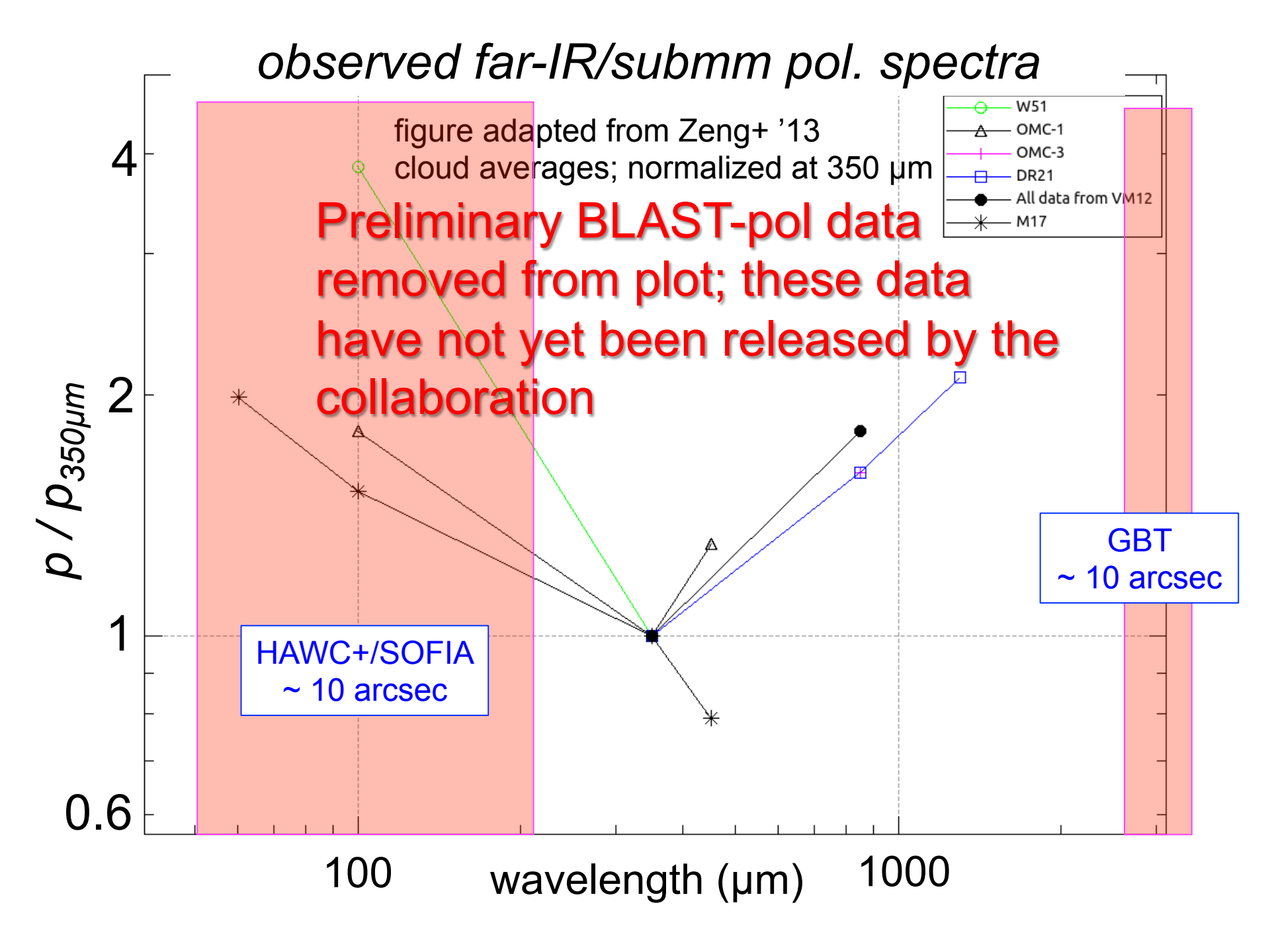


target clouds in *Planck 850 μm* (red) + *IRAS* (blue)



observed far-IR/submm pol. spectra




observed far-IR/submm pol. spectra
figure adapted from Zeng+ '13
cloud averages; normalized at 350 μm
Preliminary BLAST-pol data removed from plot; these data have not yet been released by the collaboration
W51
OMC-1
OMC-3
DR21
All data from VM12
M17
HAWC+/SOFIA
~ 10 arcsec
GBT
~ 10 arcsec
p / p350μm
4
2
1
0.6
100
wavelength (μm)
1000

conclusions

(1) Dust emission polarimetry can be used for quantitative study of B-fields in molecular clouds, *provided that we can understand how alignment efficiency varies.*

(2) A way forward is comparing observations with simulations that include variations in grain alignment efficiency.

(3) Polarization spectra …

…show little structure for relatively uniform dust populations *(preliminary result)*

…show strong structure near OB clusters (Zeng+ ‘13)

(4) Polarization spectra can provide another good point-of-comparison between observations and simulations that include variable alignment efficiency.

thanks to:

- BLASTPol 2012 collaborators:

F. Angile, M. Devlin, B. Dober, N. Galitzki, J. Klein U. Penn
S. Benton, N. Gandilo, P. Martin, C. B. Netterfield, J. Shariff U. Toronto
P. Ashton, L. Fissel, T. Matthews, F. Santos Northwestern U.; CIERA
P. Ade, E. Pascale, C. Tucker Cardiff U.
A. Korotkov, G. Tucker Brown U.
F. Poidevin, G. Savini U. C. London
D. Ward-Thompson U. Central Lancashire
Y. Fukui U. Nagoya
N. Thomas NASA-Goddard
L. Moncelsi Caltech
D. Scott UBC
Z.-Y. Li U. Virginia
J. Soler CNRS-IAS
F. Nakamura NAOJ

- NASA Grant: NNX13AE50G S03