
Dust to dust
Emission, Extinction, & Grain Growth
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Astronomy & Astrophysics

Smoke in the Pipe Nebula: dust emission and grain growth in the starless core FeSt 1-457

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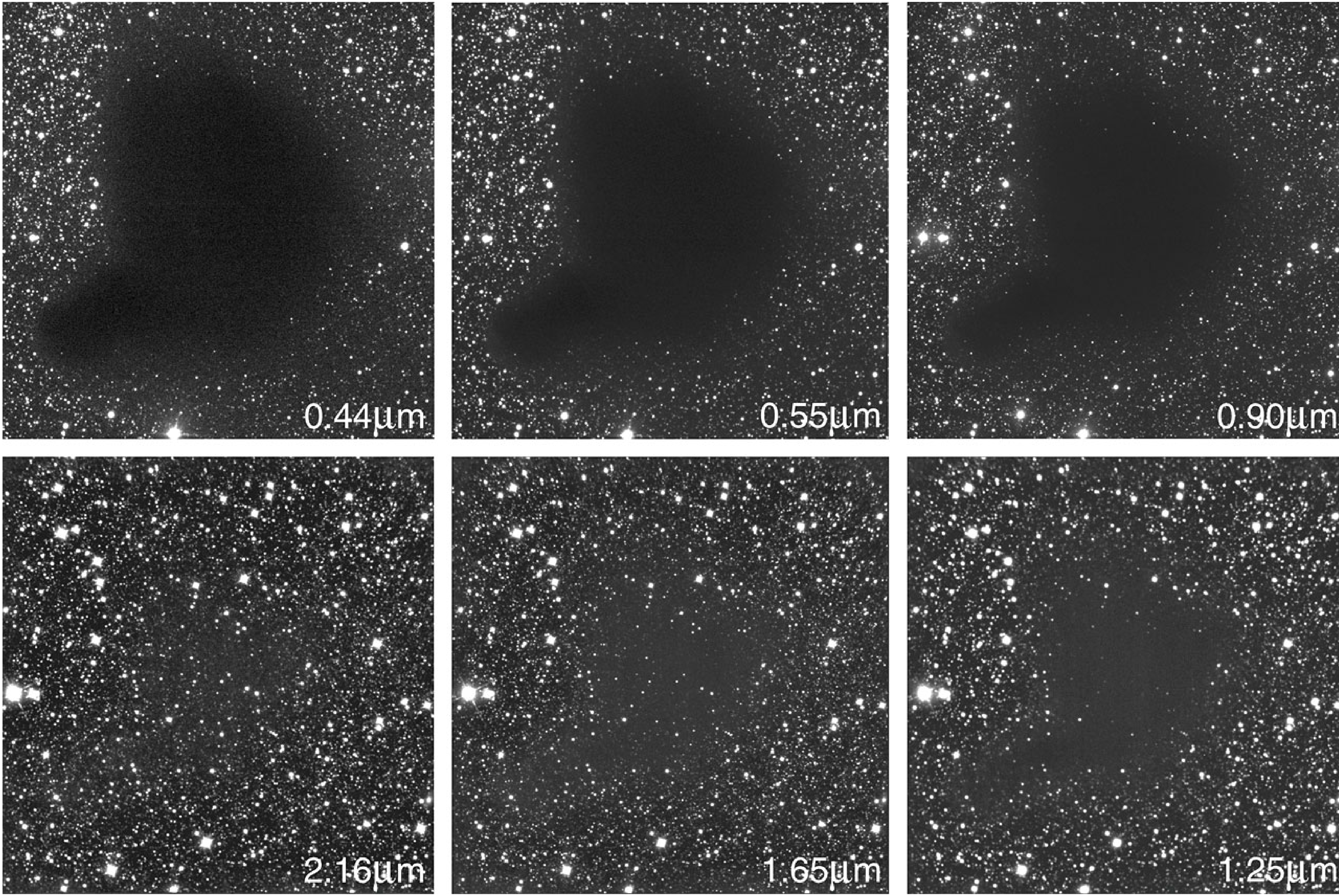

Barnard 68 – Alves et al. (2001), ESO

THE ASTROPHYSICAL JOURNAL, 429:694–709, 1994 July 10

DUST EXTINCTION AND MOLECULAR GAS IN THE DARK CLOUD IC 5146

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ABSTRACT

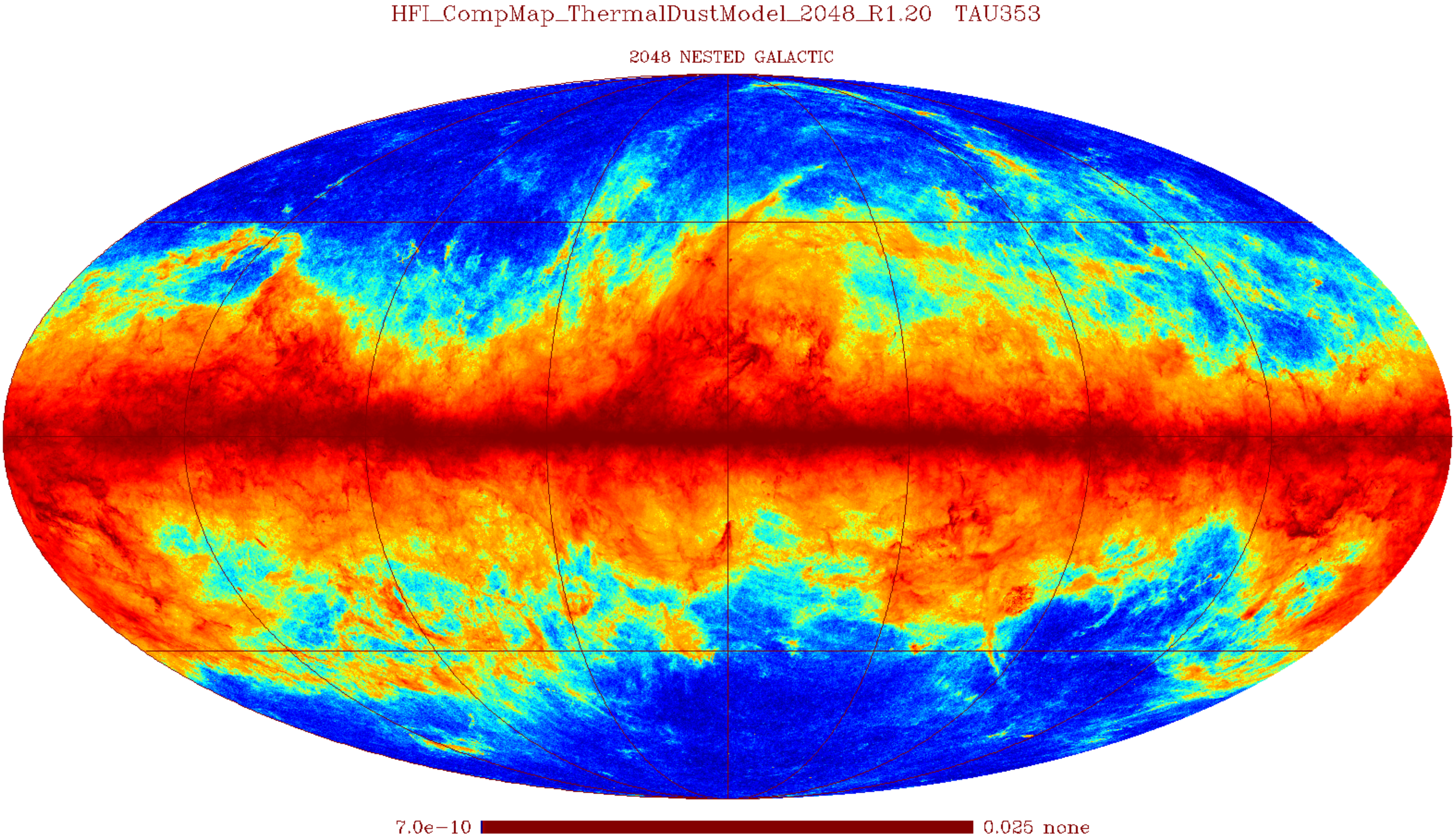
In this paper we describe a powerful method for mapping the distribution of dust through a molecular cloud using data obtained in large-scale, multiwavelength, infrared imaging surveys. This method combines direct measurements of near-infrared color excess and certain techniques of star counting to derive mean extinctions and map the dust column density distribution through a cloud at higher angular resolutions and greater optical depths than those achieved previously by optical star counting.

We report the initial results of the application of this method to a dark cloud complex near the cluster IC

Refined by Marco Lombardi: NICE, NICER, NICEST

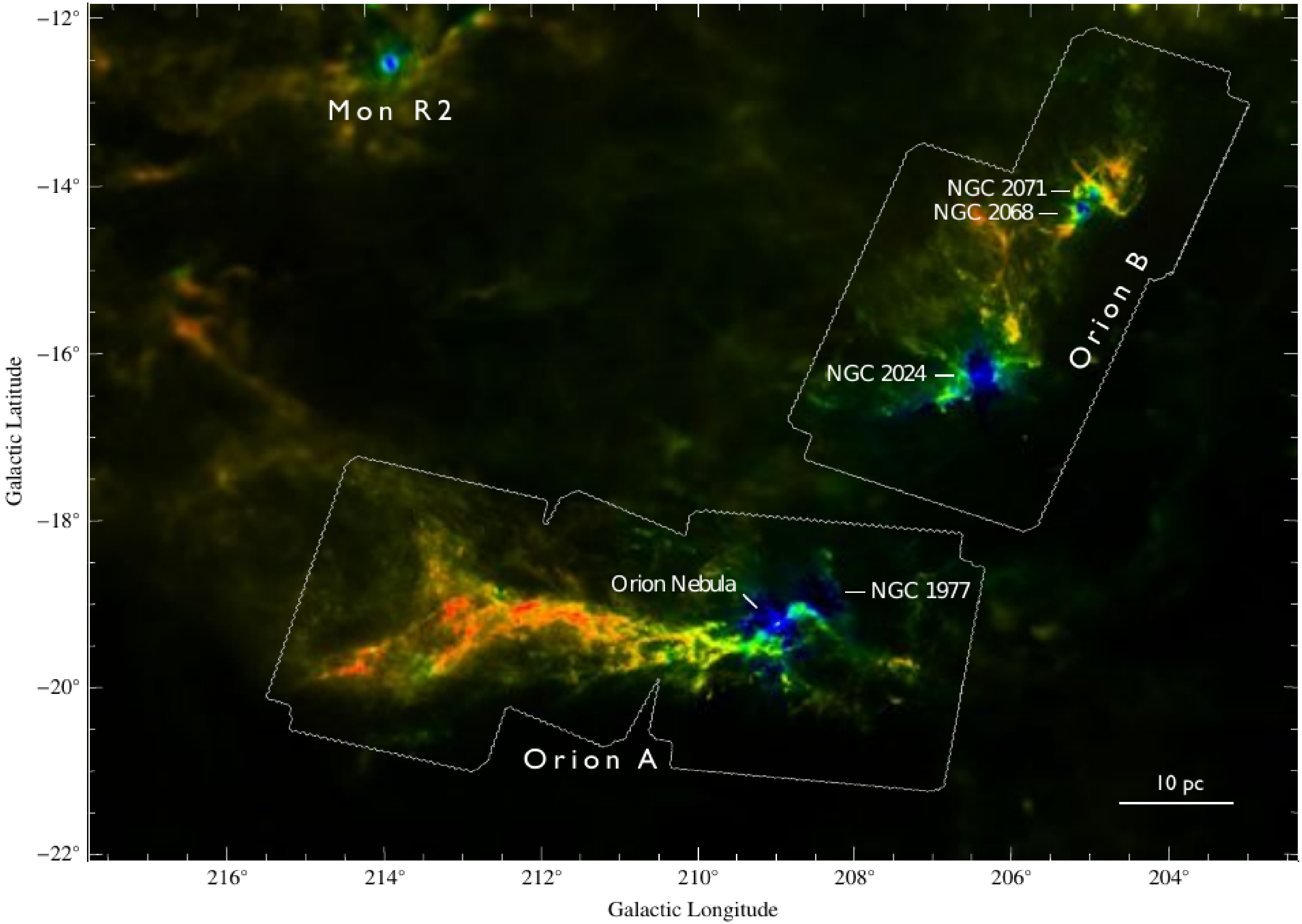
Review in Lada et al. (2007), in PPV proceedings

Planck 2013 results. XI. All-sky model of thermal dust emission*



Dust model based on modified-blackbody fit to 100, 350, 550, 850 μm data

$$I_\nu = \tau_{\nu_0} B_\nu(T_{\rm obs}) \left(\frac{\nu}{\nu_0}\right)^{\beta_{\rm obs}}$$

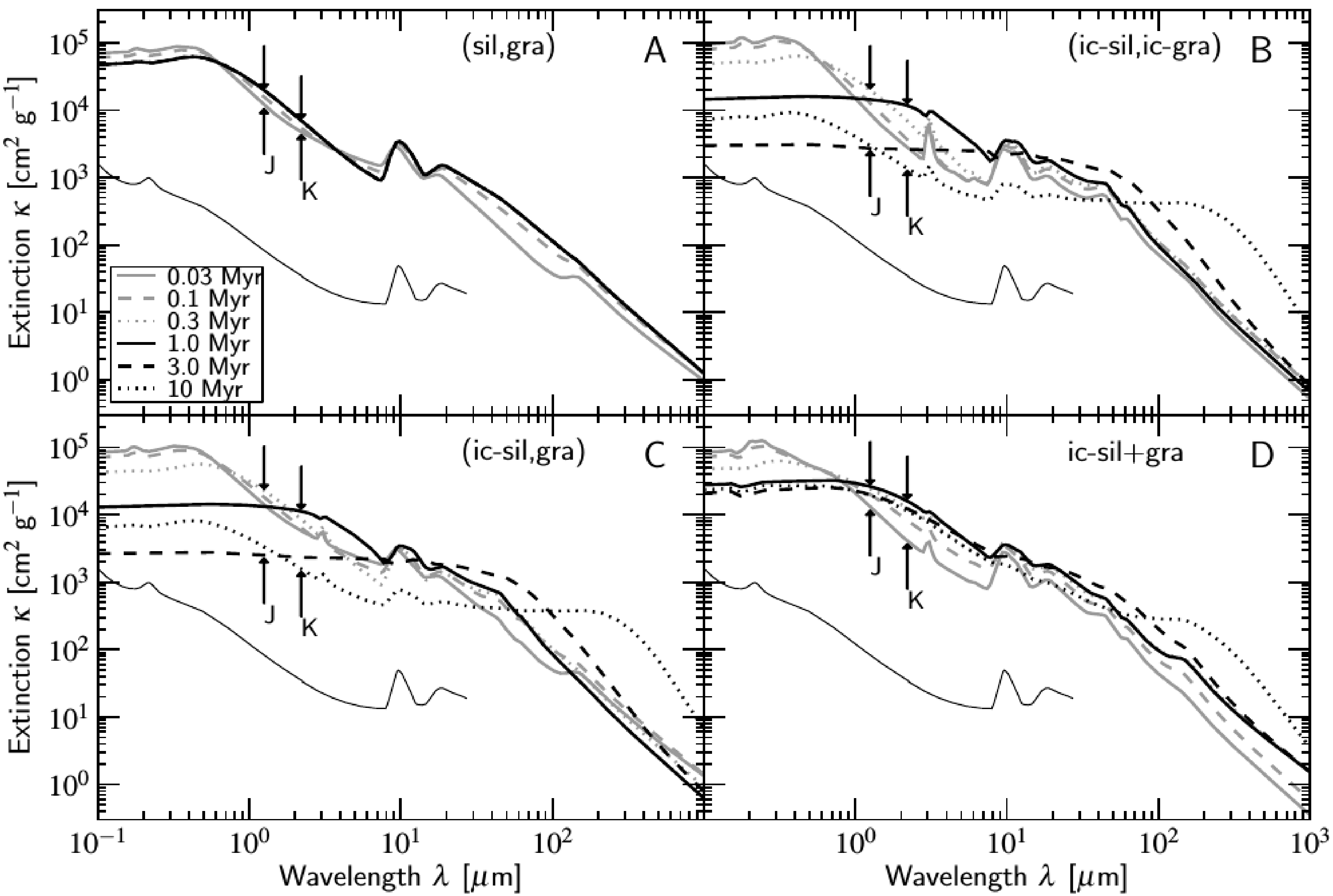


Extending the *Planck* dust model with *Herschel* data: **Orion** – Lombardi et al. (2014)

Dust coagulation and fragmentation in molecular clouds

II. The opacity of the dust aggregate size distribution

C. W. Ormel[1], M. Min[2], A. G. G. M. Tielens[3], C. Dominik[4], and D. Paszun[4]



Ormel et al. (2011)

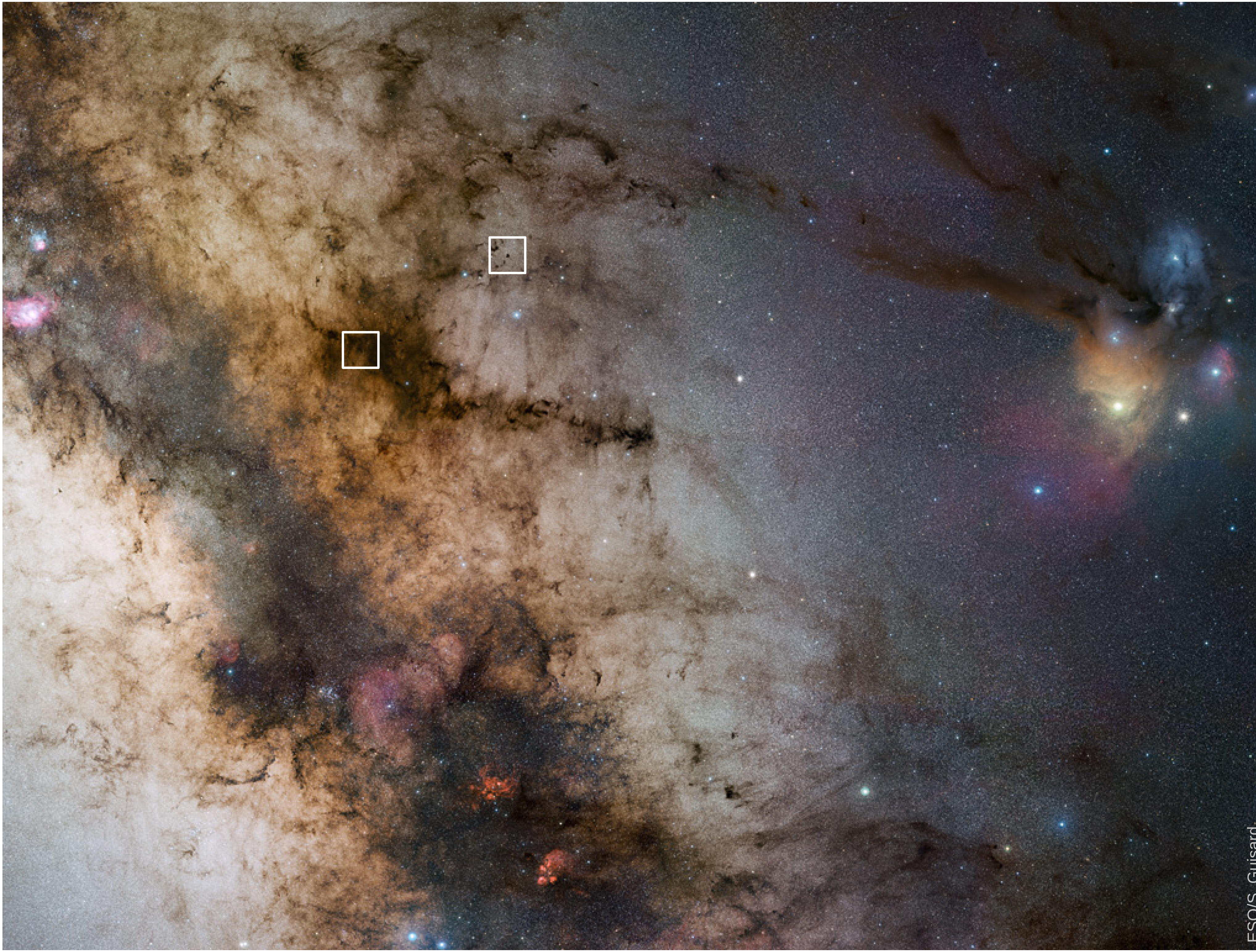
Premise for this project

1 We select "simple" starless cores without internal heating sources (FeSt 1-457 / B 68).

2 We use a comprehensive dataset consisting of VLT extinction, Laboca, Herschel maps.

3 The goal is to obtain *empirical* dust property constraints that are independent of a) spatial filtering and b) temperature assumptions.

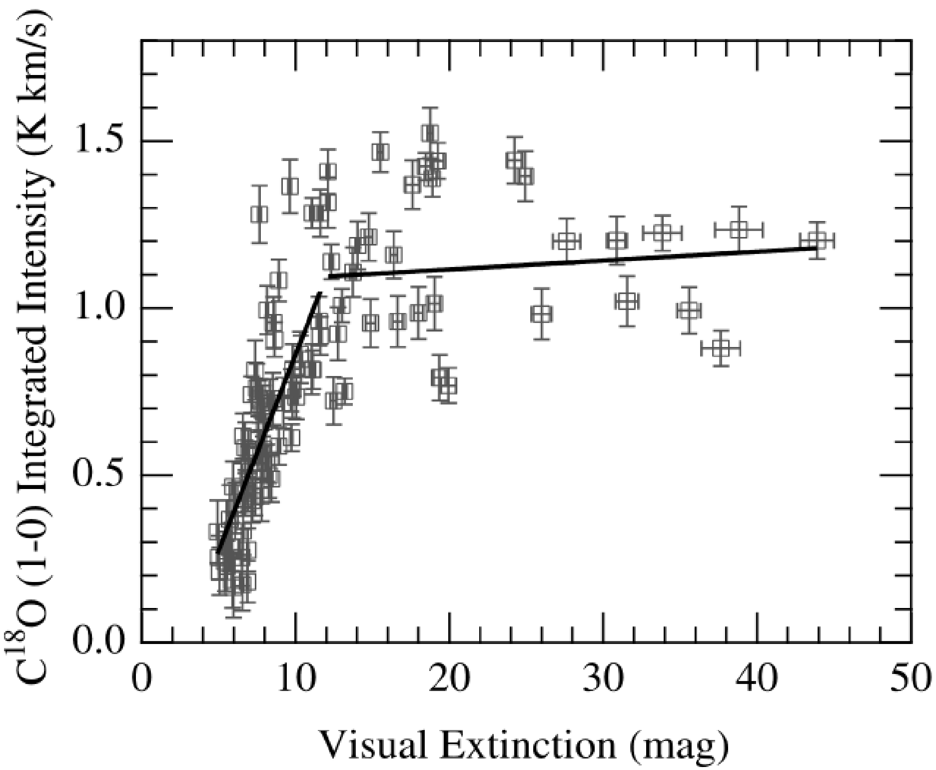
4 No detailed modelling of the core.

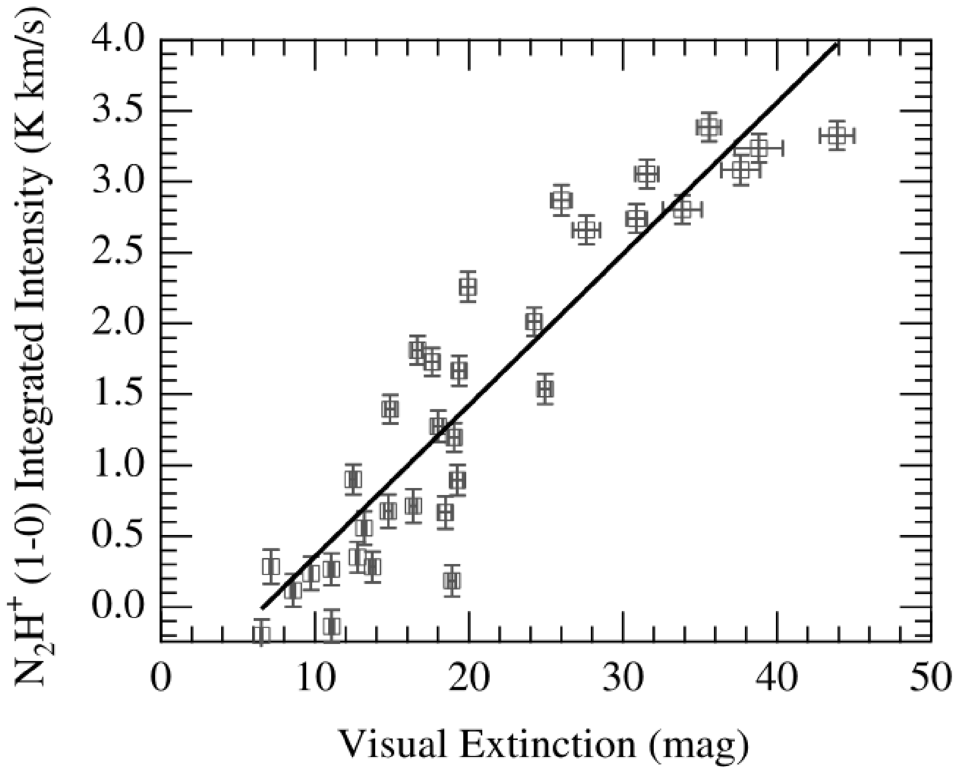

ESO/S. Guisard

THE DYNAMICAL STATE OF THE STARLESS DENSE CORE FeSt 1-457: A PULSATING GLOBULE?

E. D. Aguti,[1] C. J. Lada,[2] E. A. Bergin,[3] J. F Alves,[4] and M. Birkinshaw[1]

Received 2007 January 23; accepted 2007 April 27





Aguti et al. (2007)

The mid-infrared extinction law in the darkest cores of the Pipe Nebula⋆

J. Ascenso[1], C. J. Lada[2], J. Alves[3], C. G. Román-Zúñiga[4], and M. Lombardi[5]

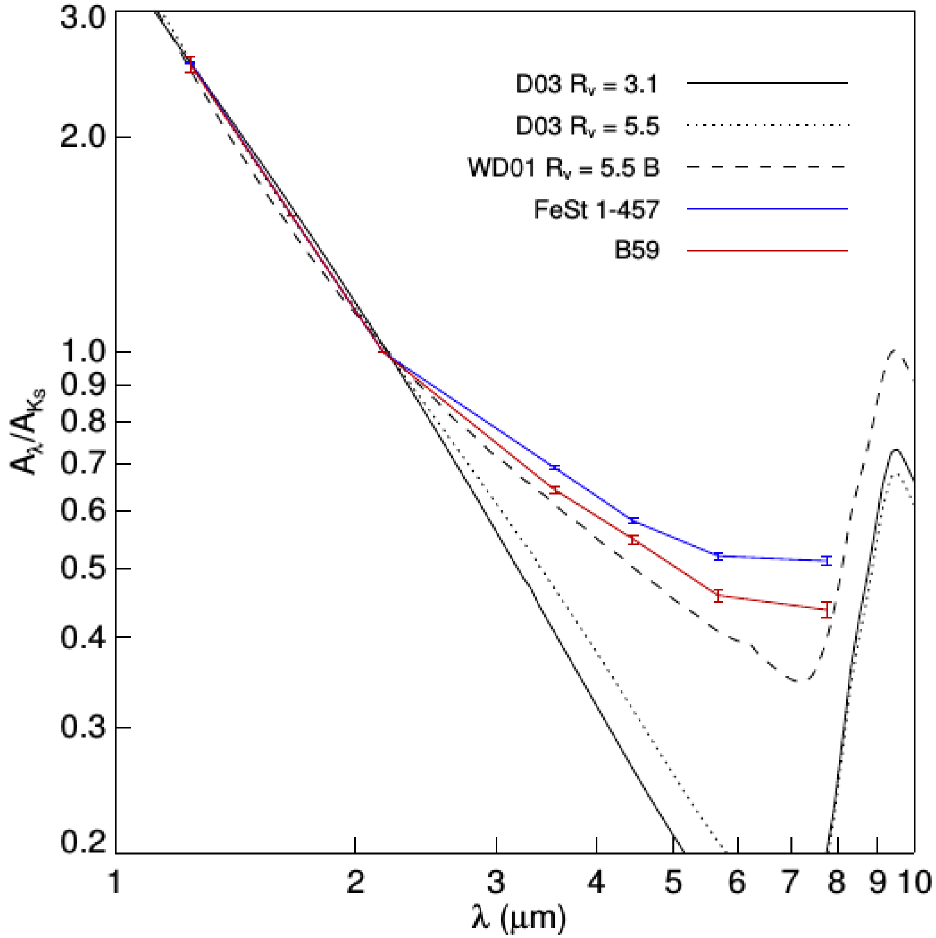
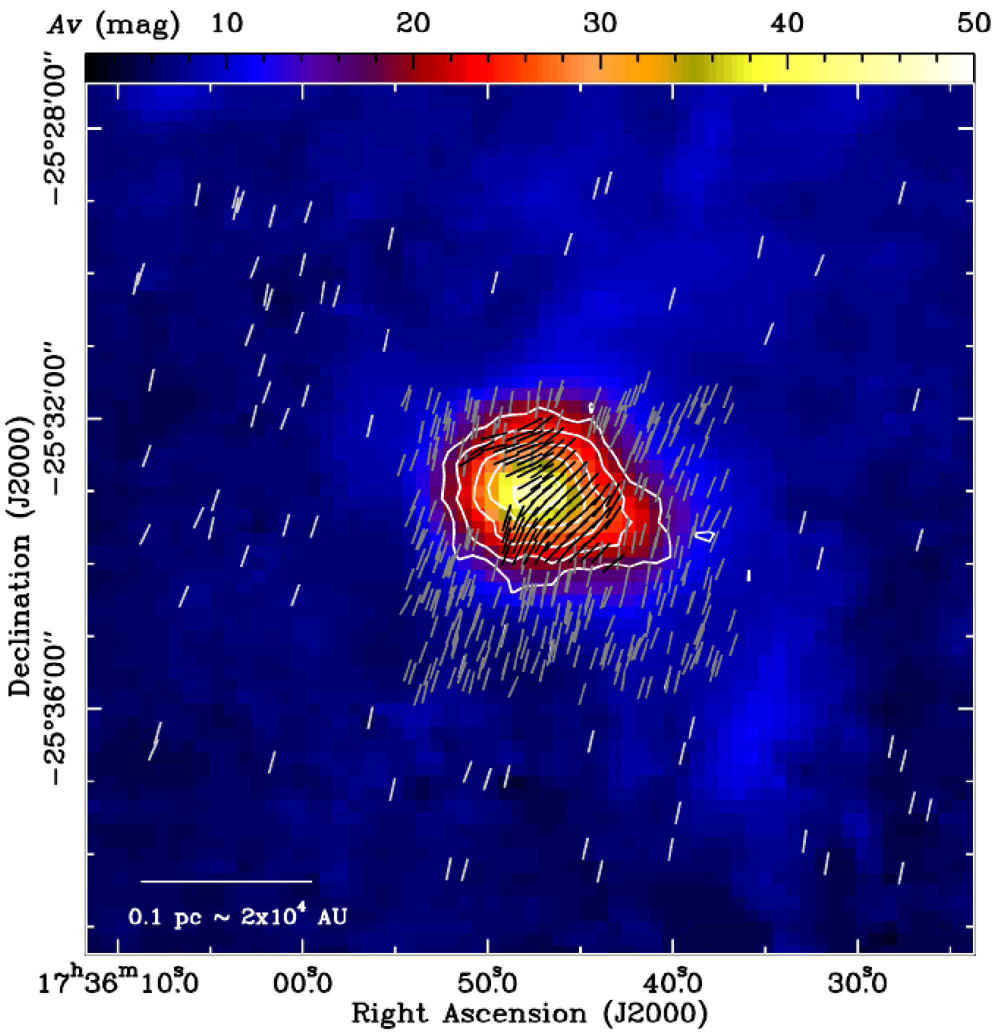


Fig. 3. Extinction law for FeSt (blue line) and B59 (red line). Also shown are the Draine (2003a,b) models for R_V = 3.1 (solid line) and R_V = 5.5 (dotted line), and the Weingartner & Draine (2001) models for R_V = 5.5, case B (dashed line).

Ascenso et al. (2013)

On the radiation driven alignment of dust grains: Detection of the polarization hole in a starless core★,★★

F. O. Alves[1,★★★], P. Frau[2,3], J. M. Girart[4], G. A. P. Franco[5], F. P. Santos[6], and H. Wiesemeyer[7]



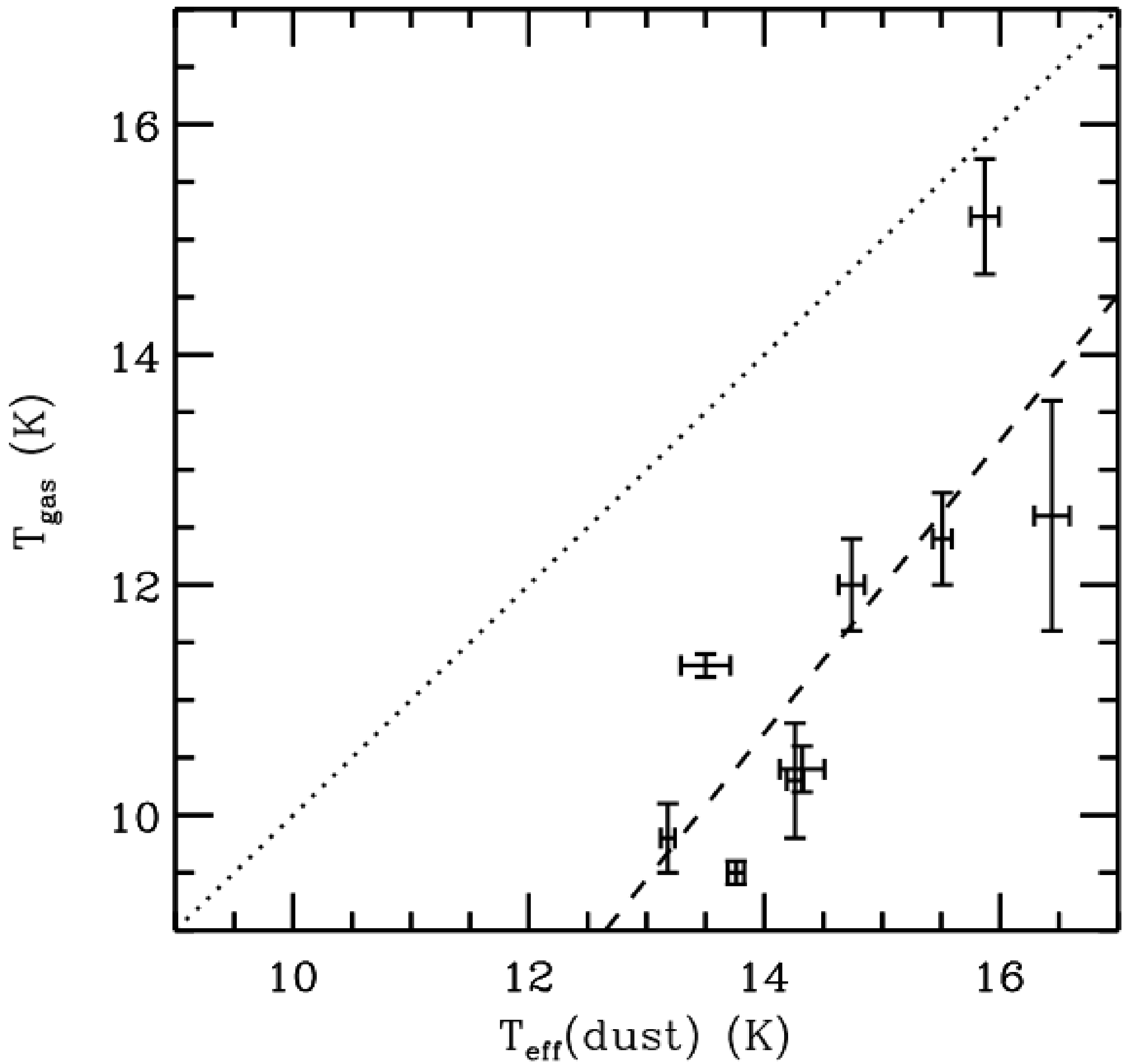
Alves et al. (2014)

Step 1

Ascertaining a physical meaning of the effective dust temperature

(Inter)comparisons of dust and gas tracers

NH3



Forbrich et al. (2014)

Step 2

FeSt 1-457 – the data:
Constraining the submm dust opacity
with *Herschel* and NIR extinction

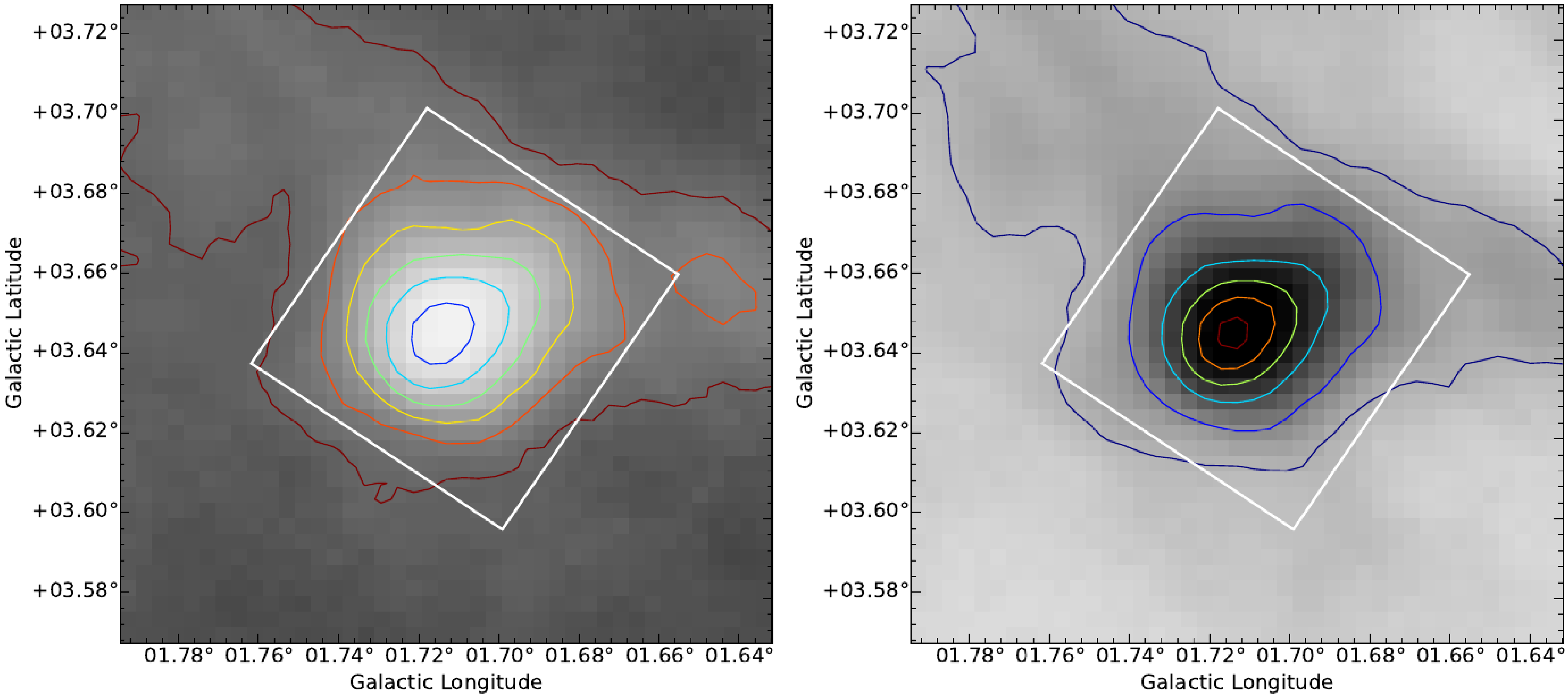


Fig. 2. Left: Effective dust temperature map of FeSt 1-457, 36″ FWHM, with contours indicating temperatures of 20 K down to 14 K in steps of 1 K. Right: Corresponding optical depth map, with contours indicating levels of 2, 3, 5, 7, 9, and 11×10^{-4}. In both panels, the white box indicates the field of view of Figure 1.

Starless core **FeSt 1-457** – Forbrich et al. (2015)

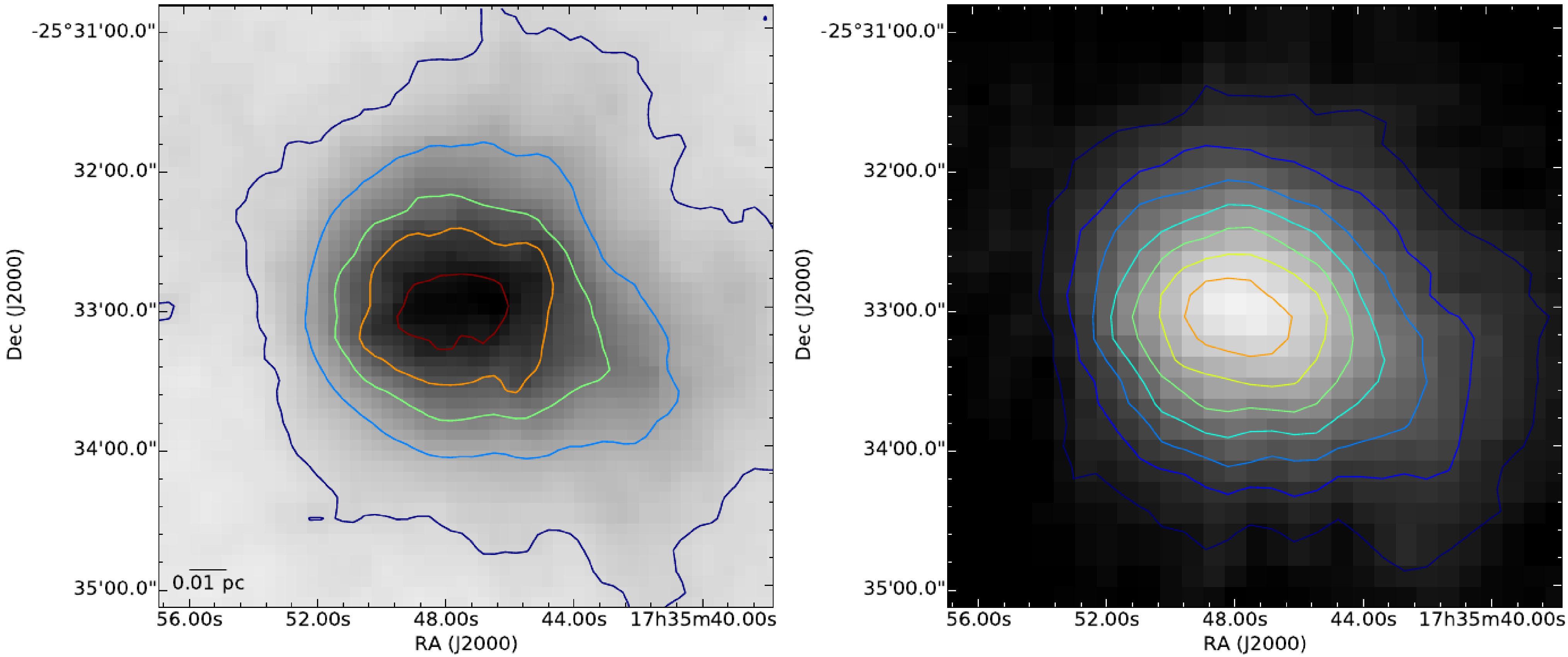
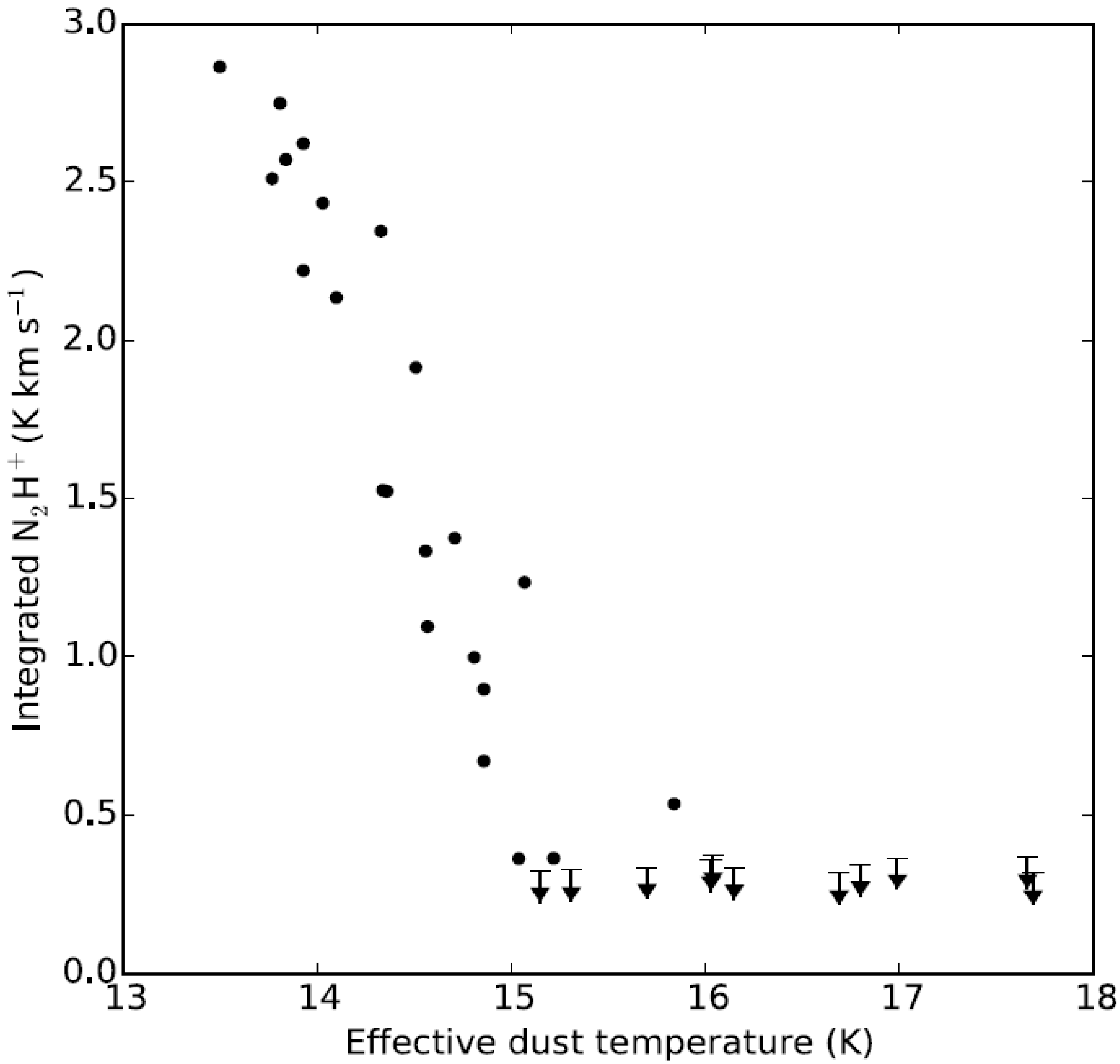
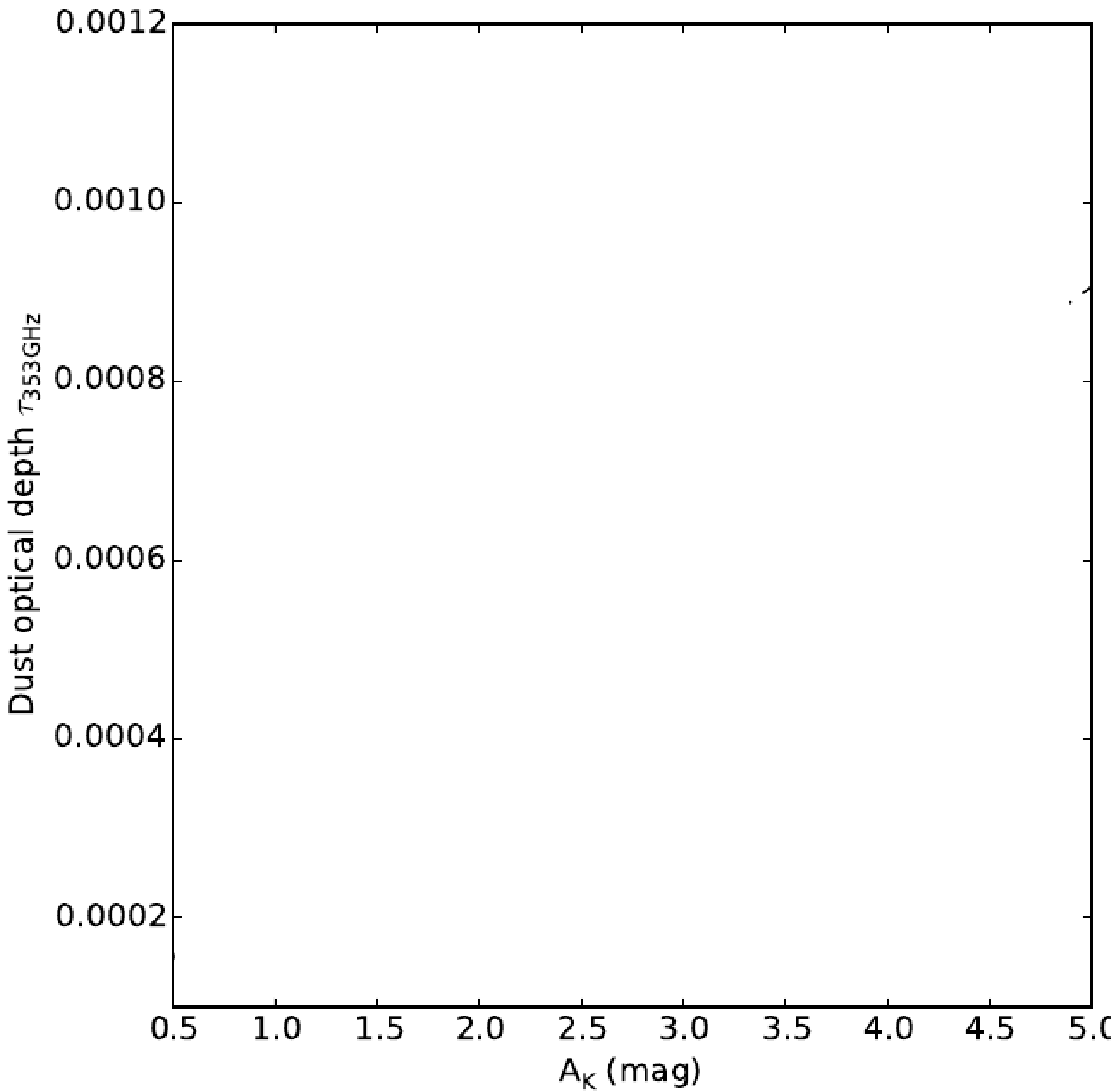


Fig. 1. Left: Near-infrared extinction map, resolution: 9″ FWHM. Contours indicate levels of A_K=1 to 5 mag, in steps of 1 mag. Right: *Laboca* 870 μm map, 18″ FWHM. Contours indicate levels of 0.033 Jy/beam, corresponding to the 3σ limit, to 0.231 Jy/beam, in steps of 0.033 Jy/beam.

Starless core **FeSt 1-457** – Forbrich et al. (2015)

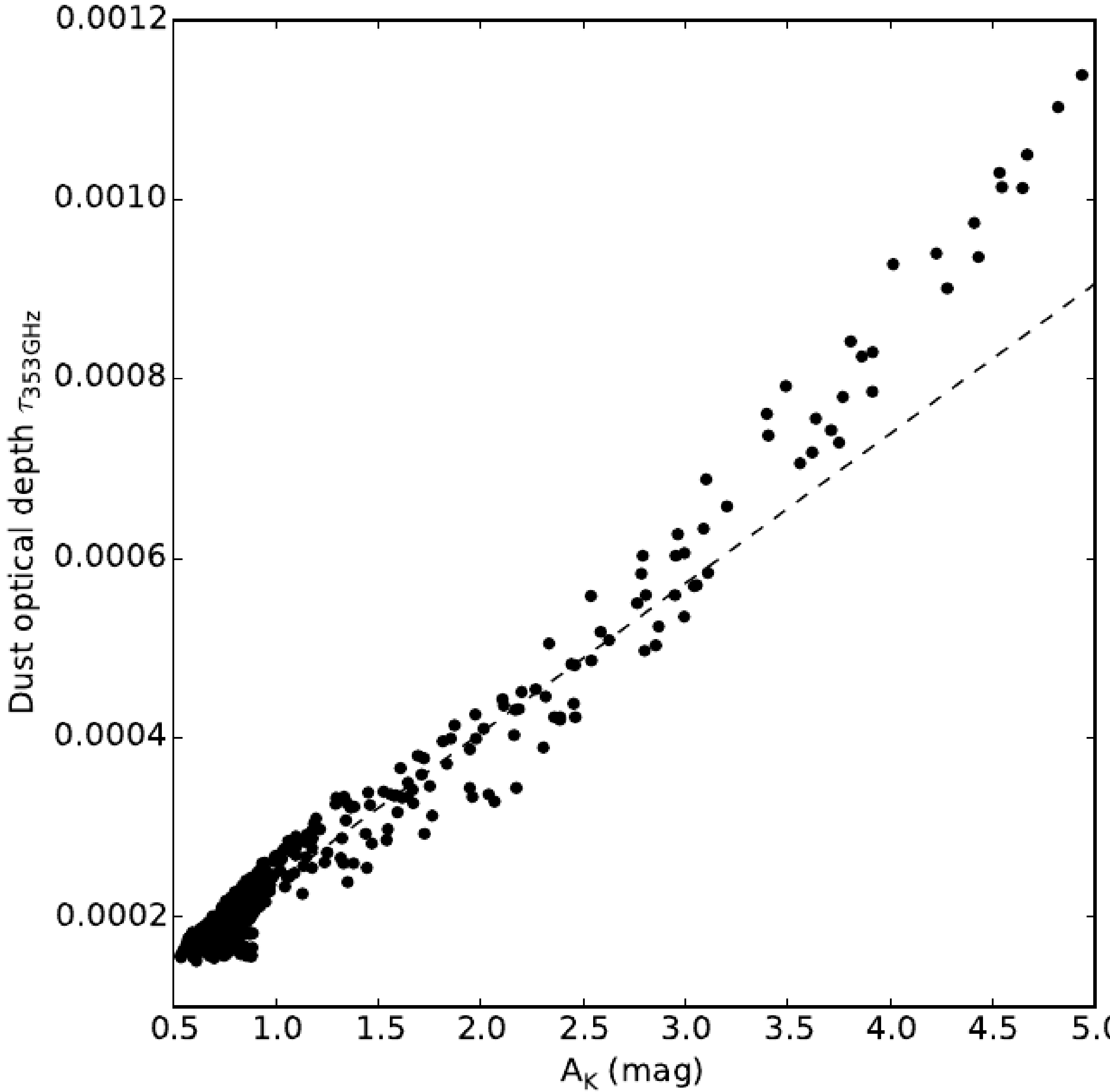


Starless core **FeSt 1-457** – Forbrich et al. (2015)



Slope proportional to ratio of submm dust opacity and NIR extinction coefficient.

Starless core **FeSt 1-457** – Forbrich et al. (2015)

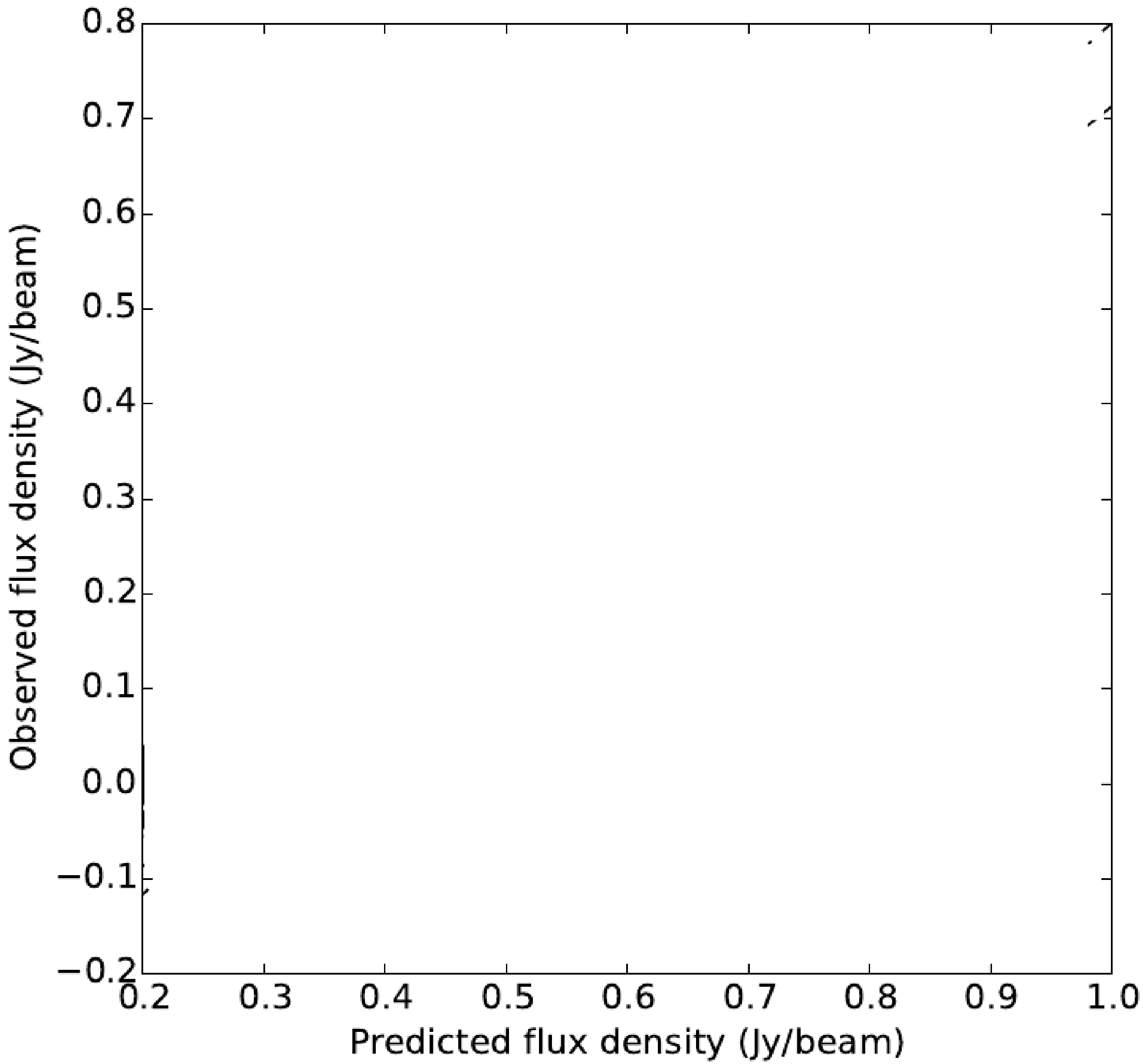


Slope proportional to ratio of submm dust opacity and NIR extinction coefficient.
Grain growth!

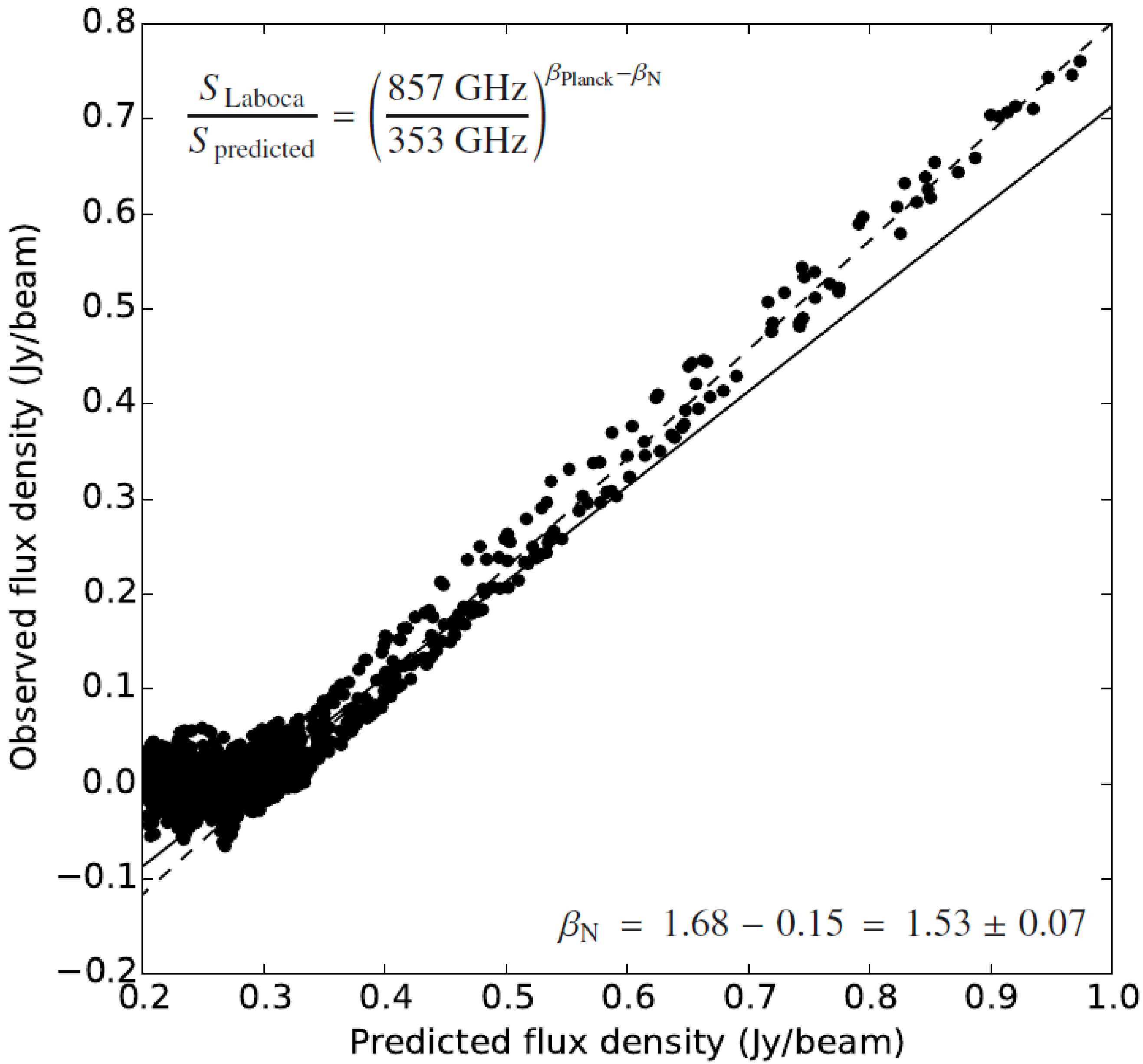
Starless core **FeSt 1-457** – Forbrich et al. (2015)

Step 3

Constraining the submm dust opacity spectral index β using *Herschel* and Laboca



Starless core **FeSt 1-457** – Forbrich et al. (2015)



A single dust opacity spectral index β still explains the data. Compatible with models of grain growth.

Starless core **FeSt 1-457** – Forbrich et al. (2015)

Summary

1 Near-infrared extinction mapping has many advantages over dust emission mapping.
2 NH_3 and N_2H^+ observations indicate a physical meaning of T*eff* (dust).
3 Dust emission and extinction observations yield evidence for grain growth in FeSt 1-457.
4 Comparing a *Herschel/Planck* dust model against two independent observations (NIR & submm) constrains κ *and* β.