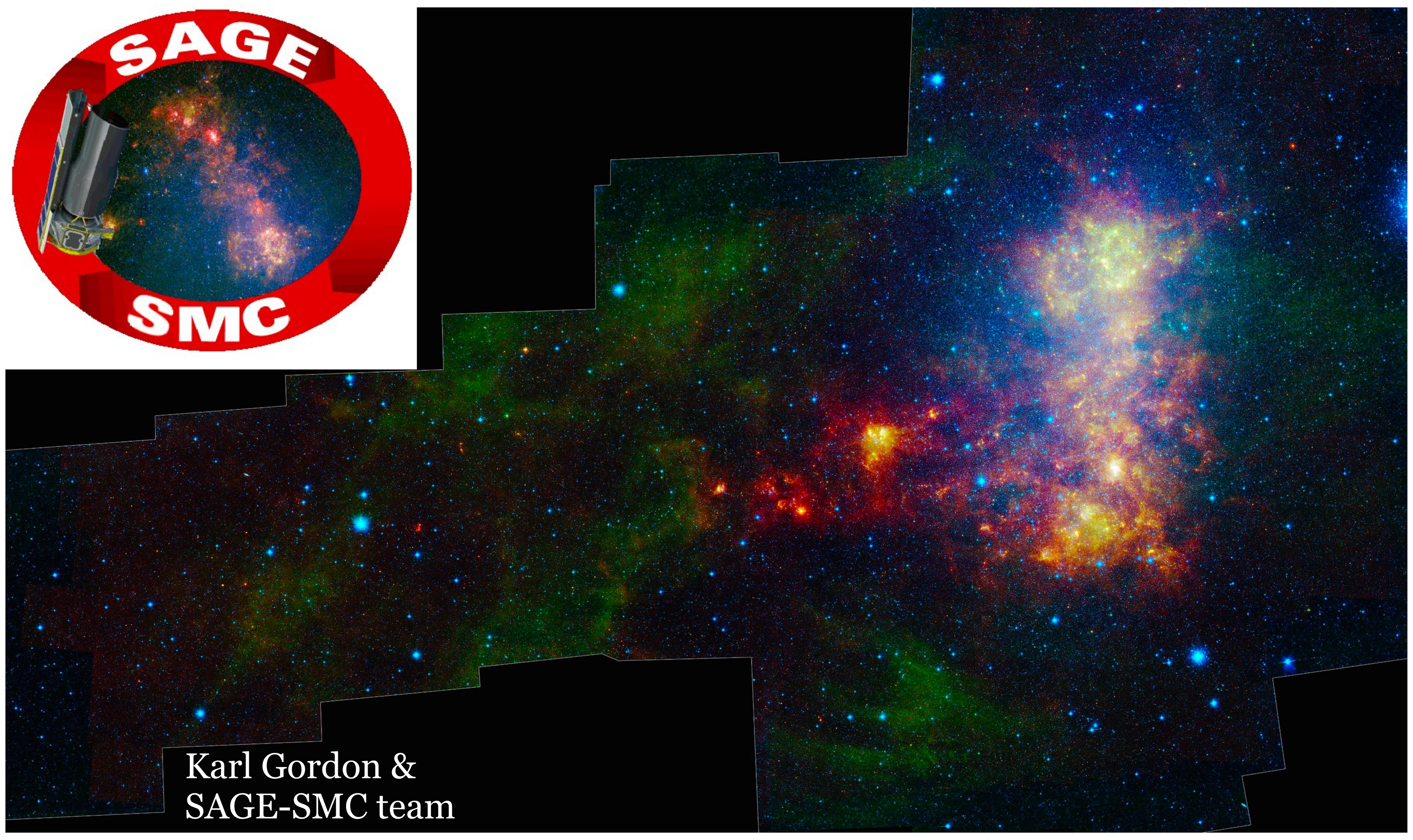

The Dust Input from Asymptotic Giant & Red Supergiant Stars to The Small Magellanic Cloud

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The Life Cycle of Dust

Asymptotic giant branch (AGB) and red supergiant (RSG) stars eject a large fraction of their mass into the interstellar medium (ISM) in the form of gas and dust. The total rate of AGB/RSG dust return is therefore a key parameter influencing galactic chemical enrichment. In this work, we use a pre-computed grid of radiative transfer (RT) models for AGB/RSG dust shells to estimate the luminosities and dust-production rates (DPRs) of the entire mass-losing population of the Small Magellanic Cloud (SMC).

We have already applied this method to estimate the AGB/RSG dust budget in the Large Magellanic Cloud (LMC; Riebel+ 2012), finding that **a small number (≈5%) of highly evolved "extreme" AGB stars produce more than 75% of the dust**. It is therefore **very important to have a complete inventory of the dustiest sources**! This detail is the crux of our current study. The paper describing these results will be submitted this month.

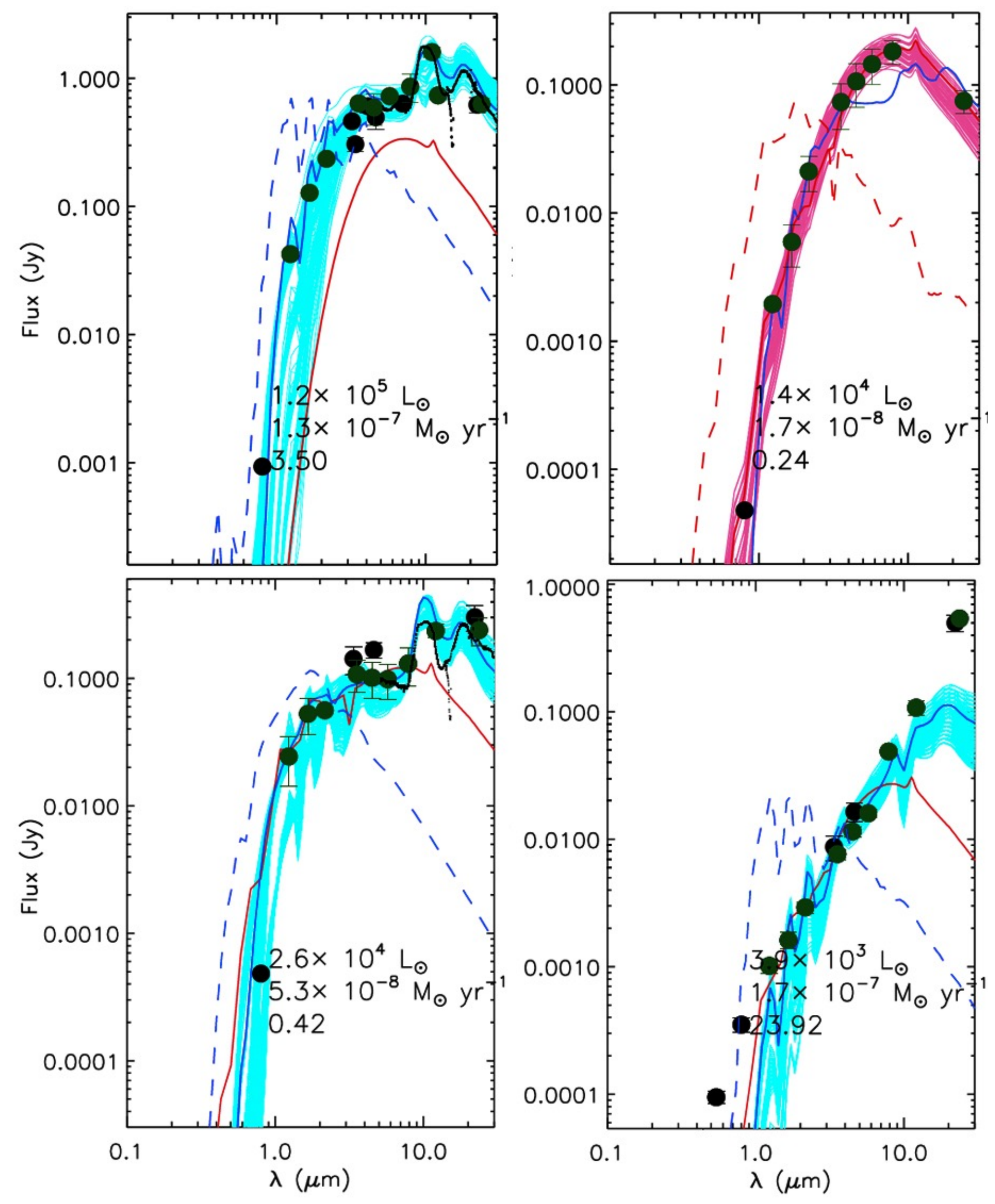
Sample Selection and Fitting Procedure

1. Compute **mean fluxes** using **multiple epochs** of data at various wavelengths to **constrain source variability**:

Wavelength Regime	Filters	Source
Optical	*UBVI*	Magellanic Clouds Photometric Survey (MCPS; Zaritsky+ 2002)
Optical	*V* and *I* (mean magnitude, amplitude)	Optical Gravitational Lensing Experiment (OGLE; Udalski+ 2008)
Near-infrared	*JHK*	2 micron All-Sky Survey (2MASS; Skrutskie+ 2006)
Near-infrared	*JHK*	InfraRed Survey Facility (IRSF; Kato+ 2007)
Mid-infrared	*Spitzer IRAC & MIPS24*	SAGE-SMC (2 epochs) + Spitzer Survey of the SMC (S^3MC, 1 epoch; Bolatto+ 2007)
Mid-infrared	*S11, L15*	AKARI (Ita+ 2010)
Mid-infrared	*W3*	Wide Infrared Survey Explorer (WISE; Wright+ 2010)

2. Use **near- and mid-IR colour-magnitude diagrams (CMDs) to select** RSG, O–rich and C–rich AGB, and extreme AGB candidates.
3. **Remove contaminants** (mainly YSOs, post-AGBs, and foreground objects). Our final sample consists of about 9,600 sources, including about 340 extreme AGB candidates.
4. **Fit with radiative transfer models** from the Grid of RSG and AGB ModelS (GRAMS; Sargent+ 2011, Srinivasan+ 2011), to find best-fit values for luminosity, dust-production rate, and chemical type (O–rich or C–rich).

Results



Photometry (circles) and IRS spectra (black; Ruffle+ 2015) fit with GRAMS models (solid blue: O–rich, solid red: C–rich). *Top*: examples of good fits, one for each chemical type. *Bottom*: examples of good (*left*) and bad (*right*) fits to FIR objects.

- **Global dust-production rate (DPR)** from all AGBs and RSGs:
  $(1.7 – 3.4) \times 10^{-6}$ M_{sun} yr^{-1}
- This number is **consistent with previous determinations** (Boyer+ 2012, Matsuura+ 2013), and this input alone **cannot explain the observed ISM dust mass**.
- Ratio of C–rich AGBs put out **three times as much dust** as O–rich AGBs. In the LMC, this ratio is about two and a half. This is **consistent with the lower metallicity** of the SMC.
- Compared to the LMC, **the SMC lacks extremely dusty sources** (e.g., sources with SiC in absorption; Gruendl+ 2008)
- The large range in global DPR is due to the **uncertain nature** of the sources with the highest DPRs – the so-called **far-infrared (FIR) objects** (Boyer+ 2012). Some of them are likely AGB stars (see figure), but their colours are consistent with young stellar objects. Mid-IR spectroscopy or long-wavelength study is necessary to confirm their identity.
- The other major source of uncertainty in DPR estimates is the **choice of optical constants**, which can cause discrepancies of **up to 5x**!!

References/Links

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STScI download site for the GRAMS models:
http://www.tinyurl.com/grams-models

Need quick GRAMS fits to your data? Try the Virtual Observatory SED Analyser (VOSA):
http://www.tinyurl.com/grams-vosa