DAY 2

COMPOSITION OF SOLAR SYSTEM COMETS

DATA SOURCES

COMET MISSIONS
- SAMPLE RETURN
- MASS SPECTROMETERS

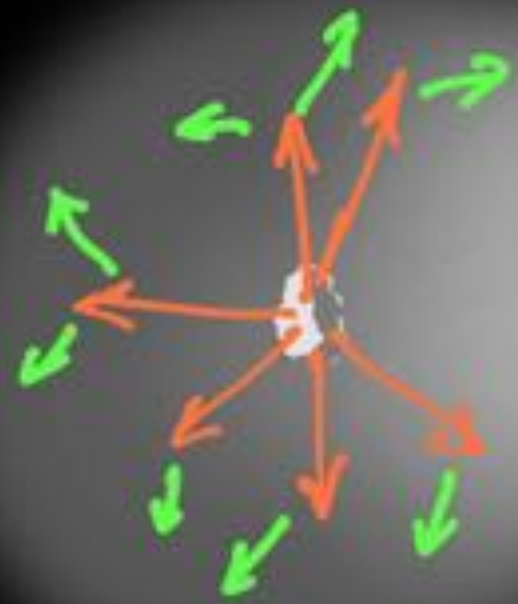
GREAT DATA, BUT LIMITED

WE NEED REMOTE SENSING DATA

TYPES OF MOLECULES VERY DIFFERENT AT DIFFERENT WAVELENGTHS

PRIMARY VOLATILES RADIO OR IR

DAUGHTER PRODUCTS VISIBLE



MOST ABUNDANT PRIMARY VOLATILES

H_2O

CO (<1 - 40%)

CO_2 (1 - 30%)

SOME EXCEPTIONS, E.G. C/2016 R2

A LOT OF N_2 + CO

G. Rhemann

ROSETTA

ROSINA - MANY MOLECULES IMPOSSIBLE TO SEE FROM GROUND.

- O_2 UP TO 10%, AVGE. 4%
- GLYCINE ...
- NOBLE GASES, ISOTOPIC RATIOS
- K. ALTWEGG'S "ZOO"

COMET TAXONOMIES

- COMPARE COMPOSITIONS OF COMETS

FAMILIES:

MAIN BELT COMETS

JUPITER FAMILY COMETS (SC. DISK)

~ ISOTROPIC COMETS

- LONG PERIOD
- HALLEY-TYPE

Nutrition Facts

Serving Size: 1 bottle (9.5 fl.oz.)
Serving per container: 1

Amount Per Serving

Calories 60 Calories from Fat 8

	% Daily Value*
Total Fat 1 g	1%
Saturated Fat 0 g	0%
Trans Fat 0 g	
Cholesterol 0 mg	0%
Sodium 60 mg	3%
Potassium 420 mg	12%
Total Carbohydrate 13 g	4%
Dietary Fiber 1 g	6%
Sugars 10 g	
Protein 0 g	

Calcium 2% • Magnesium 2%

* Percent Daily Values (DV) are based on a 2,000 calorie diet.

SEEM TO BE 2 CLASSES BASED ON PROD. VOLATILES

SOME DEPLETED IN CARBON CHAIN SPECIES $C_2 + C_3$

MANY SUB-CLASSES POSSIBLE

FORMATION VS. EVOLUTION?

TAXONOMY FROM PRIMARY VOLATILES

- NO CLEAR GROUPING

EACH COMET
A UNIQUE FINGERPRINT

- NO CLEAR DIFFERENCE BETWEEN DYNAMIC FAMILIES

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NO "TYPICAL" COMET

COMPLICATION: COMPOSITION OF COMET CHANGES

- DIURNALLY
- WITH HELIOCENTRIC DISTANCE

EXOCOMET COMPOSITIONS

- GAS DETECTIONS WITH SPECTROSCOPY

β PIC CaII

VARIABLE SATURATION, REDSHIFT

→ SMALL GASEOUS CLOUDS

- UV → Al, Fe, Mg MAINLY IONIZED OR STRONGLY IONIZED.

FIRST DIFFICULTIES - < 1 DAY VARIABILITY
- STRONG BLENDS
- ALMOST NO BLUE SHIFTS

27 YEARS LATER >1500 SPECTRA

- Ca II & Fe I
- Fe I << Fe II
- Fe II VARIATIONS
- Al III VARIATIONS

HIGHLY IONIZED SPECIES, eg. C IV
SHOCK IN addition TO UV.

STARGRAZERS $< 5 R_*$ @ β Pic
> 200 km s^{-1} REDSHIFT
SHAPE WELL REPRODUCED

ISOTOPES

C & O DREDGED UP IN EVOLVED STARS

PATTERN OF D/H IN SOLAR SYSTEM GENERALLY CONSISTENT WITH SOLID ACCRETION

SPECTRAL FINGERPRINTS OF ISOTOPOLOGUES

MODEL:

CHEMISTRY → OPACITIES → TEMP.

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SYNTHETIC OBSERVATION + REDUCTION → PARAMETERS

DOPPLER IMAGING NEXT?

EXOCOMET COMPOSITION WITHIN BELTS

- CARRY COMPLEX VOLATILES
- FEW DATA POINTS

COLLISIONAL EVOLUTION ...

OBSERVING ICY EXOCOMETS WHEN INWARD DELIVERY TAKING PLACE

>20% OF NEARBY STARS HAVE DUST

SHORTLIVED – RADIATION PRESSURE

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MUST BE CONTINUOUSLY PRODUCED

– COLLISIONAL CASCADE

BELT LOSES MASS OVER TIME

AFTER PROTOPLANETARY DISK FORMATION,

TIME-VARIABLE RED-SHIFTED GAS + DUST

FROM INWARD – SCATTERED EXOCOMETS.

EXOCOMET GAS – ALSO MATTER OF TIMESCALES.

CO MUST BE REPLENISHED – NOT PRIMORDIAL

OTHER SPECIES? CN? PHOTODISSOCIATION IMPORTANT

DISCUSSION

- EXOCOMETS – VERY COMPLEX SCENARIOS, E.G. COLLISIONS
- VERY DIFFICULT TO MODEL.
- HAS EQUIVALENT OF NICE MODEL SCENARIO HAPPENED ELSEWHERE?
  – SCATTERING & CASCADE OF COMETS
- ARE THERE TOO MANY COMETS TO EXPLAIN, SO SOME COMETS ARE FROM OTHER STARS ANYWAY?
- "EXOCOMETS MAY BE CLOSER THAN WE THINK!"

DISCUSSION

- HOW WEIRD WOULD PARENT SYSTEM OF A LOCAL EXOCOMET HAVE TO BE TO BE OBVIOUS?
- NEARBY STARS – ALL SIMILAR ORIGINS?
- LOOK AT D/H
  - BUT VARIES AT ONE COMET!
  - SEVERAL TECHNIQUES – CONSISTENT?
- AGES OF COMETS – POSSIBLE? GOOD CHANCE OF SAYING WHETHER DYNAMICALLY NEW.

DISCUSSION

COMETARY SCIENTISTS ARE ALWAYS LOOKING AT THE LATEST INTERESTING COMET!