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Superaromatics, The Key to a Unified Cosmic Dust Theory

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This theory was constructed by analyzing several thousand astronomical features covering every major aspect of astrophysics and astrochemistry relating to dust. To insure consistency between disciplines the logical structure of the conclusions in each field was checked rather than accepting the current consensus. This was to eliminate the problem shown in figure 1. No substantial contradictory features are known to the author.

The analysis falls into seven major parts:

1) Kinetics of grain formation and destruction.
2) Optical spectra of the ISM.
3) Meteorite/IDP chemistry.
4) Structure of the solar system and its minor components, i. e., comets, boulders, and interplanetary dust cloud.
5) Structure and chemistry of the interstellar medium (ISM) arising from surface catalysis.
6) Dynamics of circumstellar and interstellar dust clouds, including galactic morphology.
7) The chemistry and physics of previously unidentified compounds.

Due to lack of space and time only tentative conclusions are presented here. A full explanation with references will be presented under different cover after funding is obtained.

The principle conclusion is that quantum mechanics as it is normally formulated is incomplete. The probable cause is that it is formulated with complex numbers rather than the more fundamental quaternion system. The manifestation in astrochemistry is that the most stable compounds are "superaromatic" and exotic enough to confound most classical analysis. These include the following problems:

1) They exhibit "supertransparent" phases with negligible oscillator strength so that IR absorption and visible Raman spectroscopy can fail to show most vibration modes.
2) They have large negative oxidation numbers so that generally only small fragments appear in mass spectra.
3) They generate such large matrix corrections that electron-beam analysis gives erroneous results.

The principle compounds are shown in figures 2, 3, and 4.

General

Three types of dust particles dominate:
1) Core-mantle grains aggregated into long needles, which can exceed 1 mm.
2) Small grains of 55 atoms, "ferrotile".
3) Small grains mantled with silicate, hebonite, or other minerals, which can aggregate into larger particles.

Spectral Features

The 220 nm feature is a blending of oxide absorption in small mantles with carbyne absorption in the carbonaceous mantles. The sharper diffuse-interstellar-bands arise from the central iron atom of ferrotile. Broader ones arise from decomposition products. The very broad structure arises from small mantles.

The near IR emission arises from the ferrotile. The 3.3 μm and 11.3 μm features arise from the four C-H bonds in the molecule. Features at 3.46 μm and 12.7 μm arise from a two photon dehydrogenation process.

The carbonaeous mantles have a supertransparent pass band in the near IR which allow the silicate-core features to appear. The band edges are variable, typically appearing at 1 and 20μm. A broad resonance appears at 100μm. Wide variability in emissivity at 1mm arises from ice mantling.

Meteorite/IDP Chemistry

Fresh carbonaeous matrix is a fluid, polar solvent. This leads to the filamentary carbon seen in IDPs and the cementation of grains seen in carbonaeous meteorites. Hard carbonaeous-meteorite matrix contains superaromatic spheroidal molecules in a hydrogenated diamond matrix. The dissolution of the spheroids in oxidizing acid adds to the tetrahedral carbon giving a microcrystaline diamond grain with H, O, and N as the main impurities and with some acid-insoluble spheroids containing Ne. Soluble hydrocarbons show derivation mainly from icasohedral-C rather than planar-C.

Amorphous silicate minerals nucleate on the small grains. The superparamagnetism seen in Mossbauer spectroscopy is consistent with a clustering of small grains before their incorporation into the meteorite. During metamorphosis Fe is complexed to a limited number of sites. This leads to the olivine-iron free glass-olivine sequence of mineralization. At higher levels of metamorphosis the superaromatic carbonaeous matrix can dissolve into the silicate phase. At the highest levels of decomposition iron ends up as magnetite decorations or as metallic iron.

The replacement of iron by chromium in ferrotile creates a large electron affinity in the adjacent ring. This explains the anomalously high noble gas affinity seen in chromite-carbon. Trace element affinities arising from superaromatic chemistry are apparent in most of the mineral phases of meteorites.

Solar System Structure

During the aggregation of planetesimals into planets, the carbonaeous matrix is ductile, allowing the smaller planetesimals to survive fragmentation and become comets. At the currently colder temperatures the matrix is brittle, allowing the comets to fragment into boulders and dust. Ice reacts with silicate at 200 K allowing the microencapsulation of ice with a high volatile content. These microcapsules explode in cometary jets and during entry into the earth's atmosphere, fragmenting the material. Material close to the sun can bake into carbonaeous chrondrites.

Iridium is mostly bound into a compound that is insoluble in oxidizing acids and decomposes at 1600 C. This can survive reentry in small bodies, be incorporated in the earth's crust (but escape detection), and can then be released during shock heating by meteorite impact. This leads to an underdetermination of terrestial iridium, a gross overdetermination of cometary iridium, and a gross underdetermination of the amount of cometary material hitting the earth.

The zodiacal light shows four features characteristic of cometary material:

1) A hypervelocity component from ferrotile decomposing to iron near the sun.
2) A lobe corresponding to a sharp increase in albedo between 90 and 120 degrees arising from a spherically anisotropic complex index of refraction and seen in the Halley fly-by.
3) A sharp backscattering lobe at 177+ degrees from chondrules.
4) An emission spectrum compatible with interstellar compounds.

Interstellar Medium

The electronegative external oxygen site of ferrotile allows the protenation of the electronegative ends of molecules by proton tunneling. Thus one finds a high abundance of CNH in the ISM compared to HCN. Deuterium preferentially reacts with CNH to form the more stable isomer, so DCN is abnormally abundant compared to HCN. This site catalyzes the recombination of H II to H I and then to molecular hydrogen. The large surface area of the small grains results in a radical restructuring of ISM.

Cloud dynamics

The high catalytic activity toward recombination results in a rapid (~1 million yrs.) cycling of the gas among the cold and warm phases when adequate UV flux is present. The long length of the needles results in a high ratio of far-IR radiation pressure to gravitational pressure. This pushes the needles out of the clouds into H II regions, where they are broken down into small grains and gas. The shadowing of the UV results in a modulation of the "rocket" effect, "rockets with parasols", and leads to the chaotic structure of giant molecular clouds. A near IR source of illumination, e. g., the Becklin-Neugebauer object, can attract needles, resulting in a low gas/dust ratio. Spiral arms can push the dust into cirrus and dust lanes.

Dust dynamics varies widely among galaxies. At a metallicity less than -1, UV extinction per unit of dust may be an order of magnitude lower due to the lack of metals to generate dynamic cloud chemistry.

Astronomers at Work

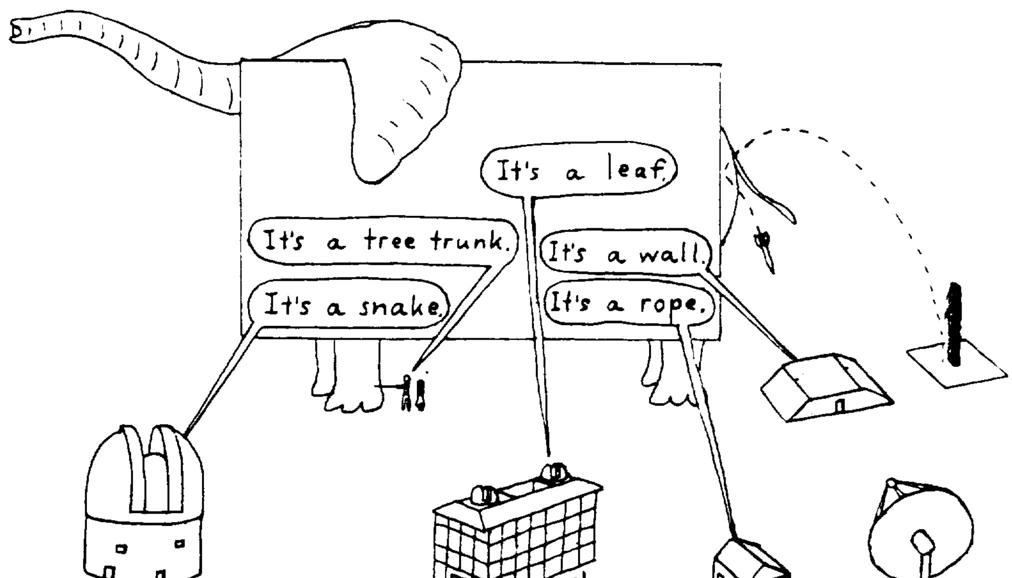
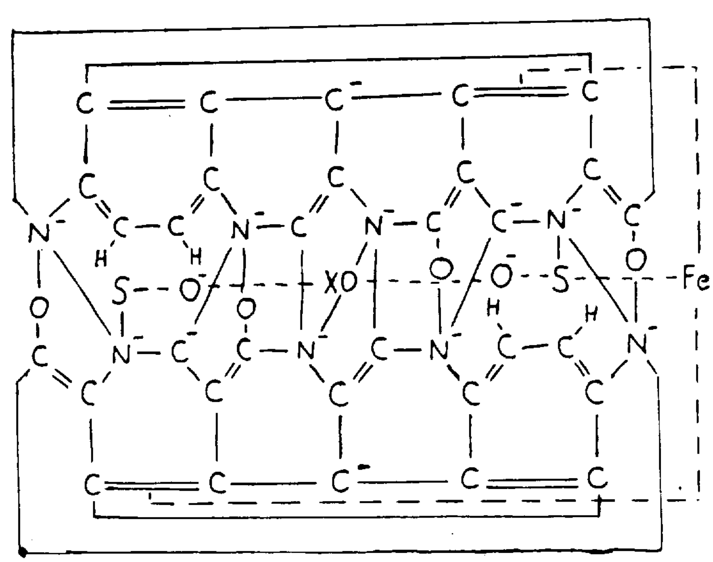


Fig. 1

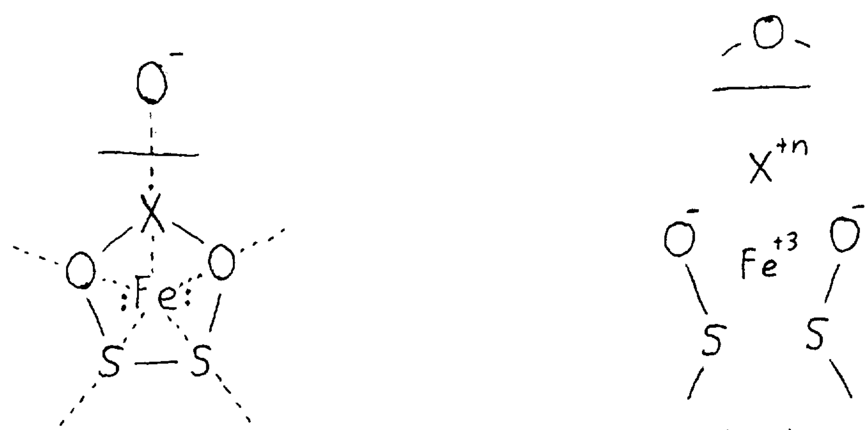
Fig. 2a "Ferrotile" $FeXC_{32}H_4N_8O_7S_2$

(small grains) $X = Al, Ca, S,$ etc.

This is the Mercator projection of an oblate ellipsoid.
See below for structure of internal ring.



Different representations of internal ring of "ferrotile". This is sandwiched between two dehydrogenated and dehydrated "pentile" monomers.



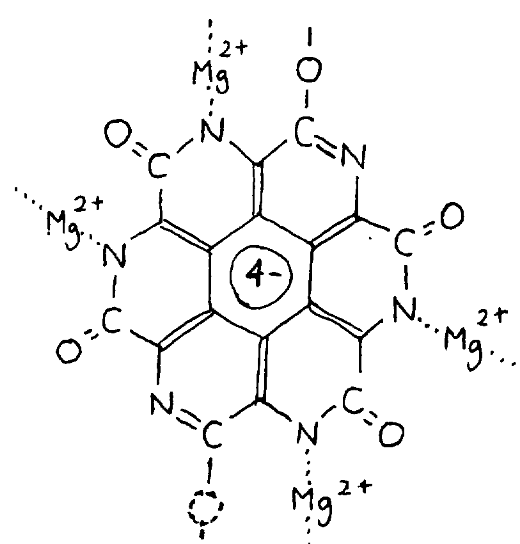
Superatomic

Fig. 2b

Kékulé
(matches diagram above)

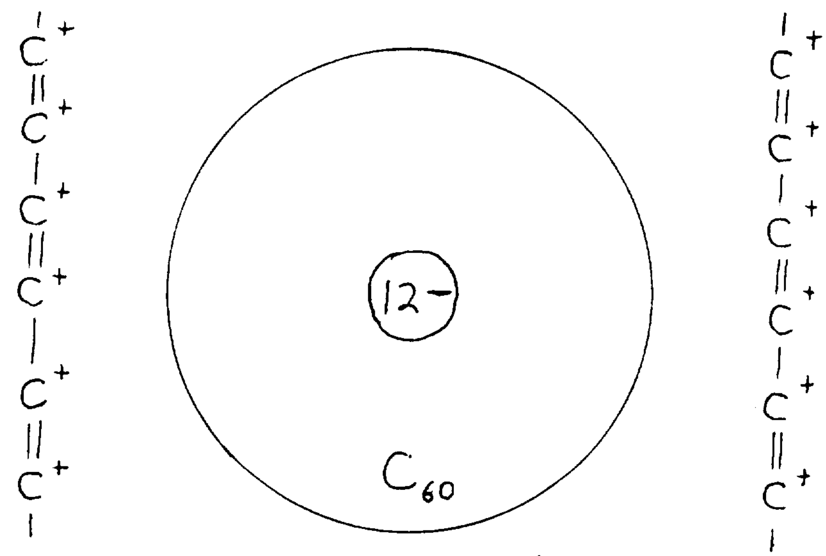
Fig. 3

Magnesium "Polycoronamide"



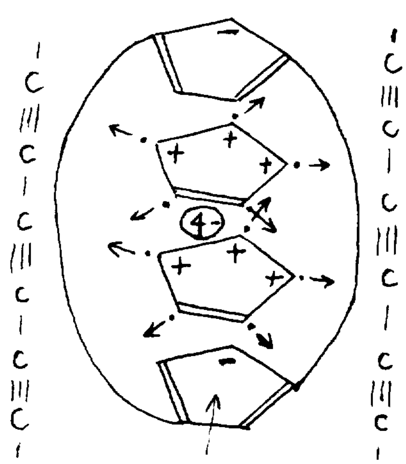
This is the main component of interstellar carbonaeous matrix, which shows a variable supertransparent pass band from about one to twenty microns (also seen in IDP's). Polycoronamide with organic cations gives a sharp mass peak at 284 daltons in laboratory UV-processed ice experiments.

Carbon polymorphs



Alpha - carbyne (C_{72})

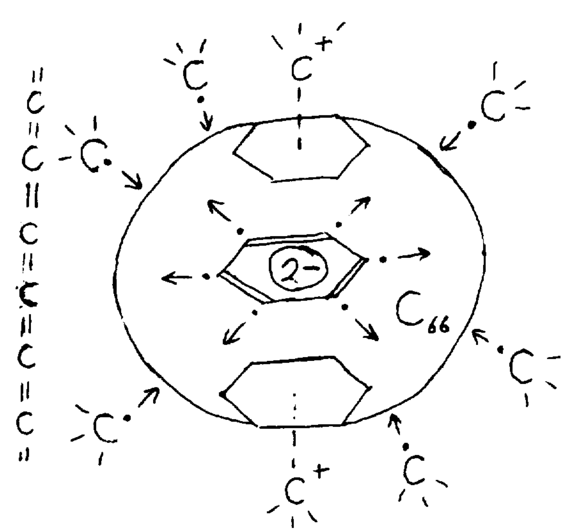
The ellipsoids are supertransparent. Only the carbyne chains appear in IR spectra and visible Raman spectra.



Carbon - XIV

C'_{70}

(C_{82})



Chaoite

C_{68} (C_{74})

Fig. 4