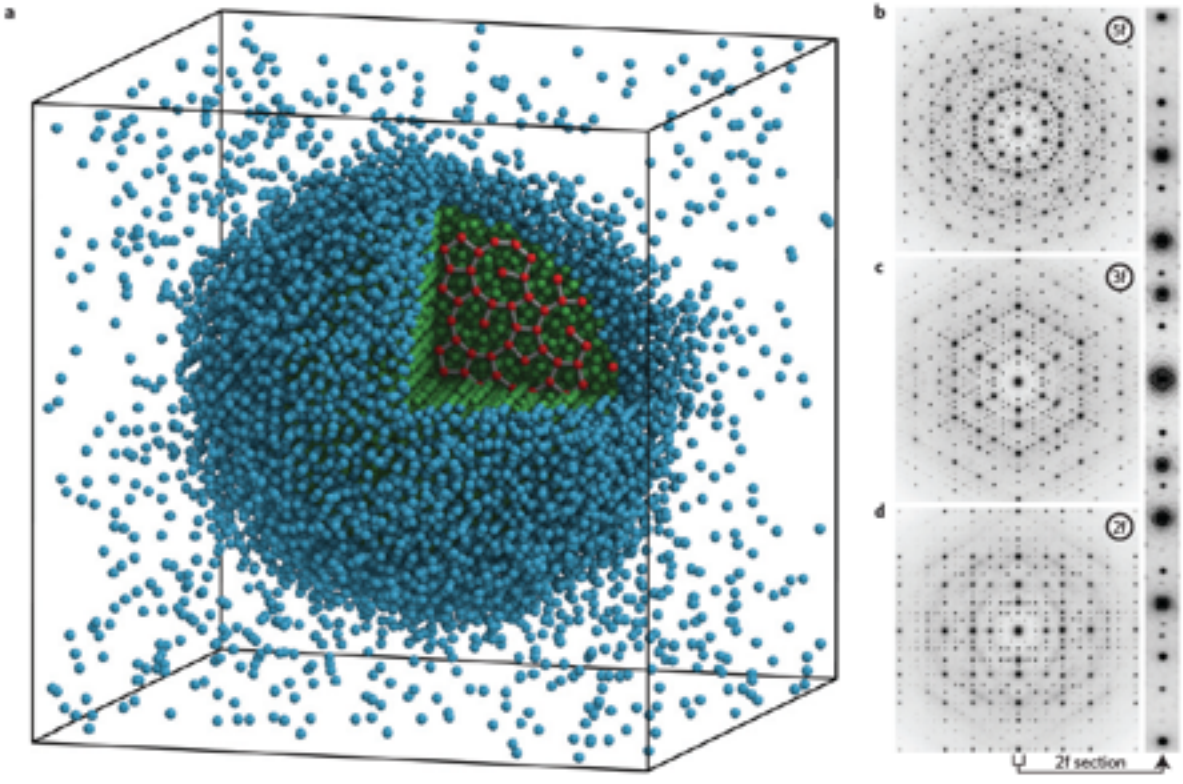
Palladium in Methanol as Realization of Icosahedral Colloidal QuasiCrystal

Frank Dodd (Tony) Smith, Jr. - viXra 2015

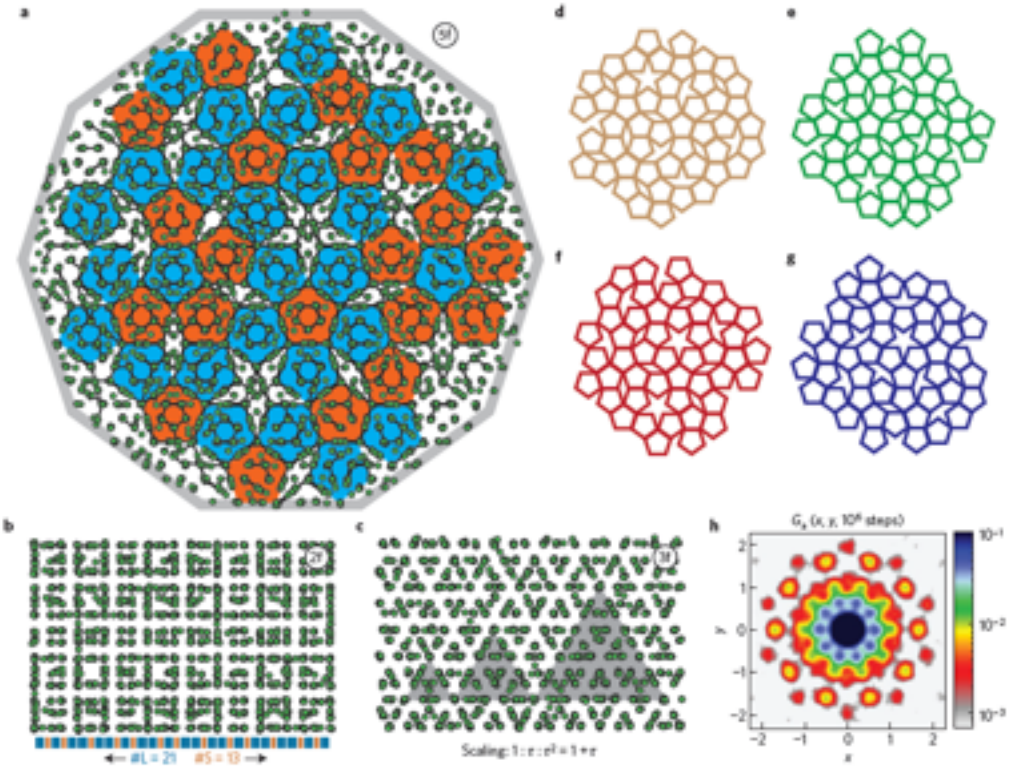
Ng, Koh, and Wong (Singapore - www.intechopen.com "25 Colloidal Crystals") said:
"... **A colloidal system** consists of
insoluble particles well-dispersed in a continuous solvent phase,
with dimensions (generally less than 1μm in at least one important dimension) that are relatively larger than the molecules of the solvent.
When the particles in this system are arranged in periodic arrays,
analogous to a standard atomic crystal with repeating subunits of atoms or molecules, they form colloidal crystals ...
Gem opal (silica particles in close packed arrangement),
iridescent butterfly wings made of periodic and spongelike pepper-pot structure ...
are typical examples of colloidal crystals found in nature ...".

Engel, Damasceno, Phillps, and Glotzer (Nature Materials 14 (2015) 109-116) said:
"... **Icosahedral quasicrystals (IQCs)** ... can be assembled by means of molecular dynamics simulations from **a one-component system of particles** interacting via a tunable, isotropic pair potential
extending only to the third-neighbour shell.
The IQC ... selfassembles from a fluid phase ...



... Diiffraction reveals two-fold, three-fold and five-fold symmetry axes ...
A detailed analysis reveals the absence of detectable phason strain ...
which allows us ... to identify the solid as indistinguishable from an IQC ...

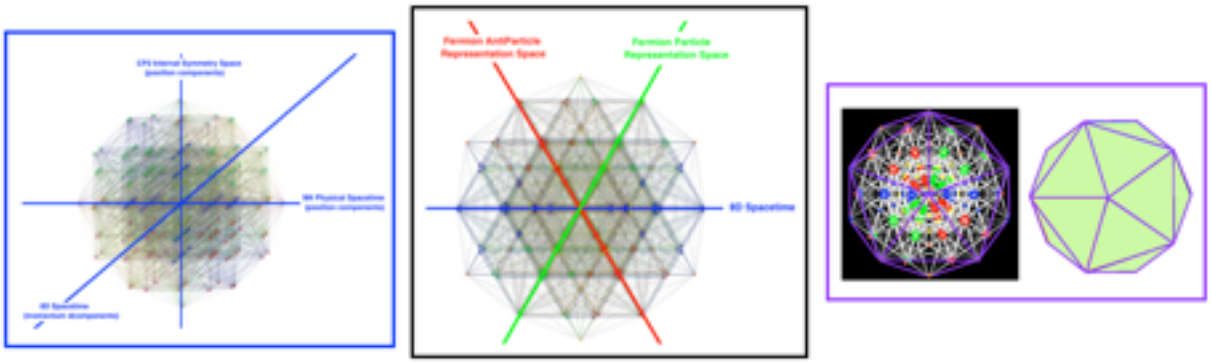
...
We carry out ... simulations of particles interacting with an effective ... oscillating pair potential (OPP) ... with three wells ... terminating the OPP after three wells ...
the three-well OPP (3w-OPP) is net attractive ...[so]... the particles will spontaneously cluster together ... in the absence of external pressure ...
The ratio of the positions of the first two wells is generally close to the golden mean ...
The IQC ... is structurally uniform, has fast dynamics and the least amount of phason disorder ... [it] achieves long-range order by relaxing the ... requirement of perfect tetrahedral coordination
...
Characterization and dynamics of the quasicrystal.



a, Particles projected along a five-fold axis are arranged into a ... Penrose tiling.
b, Projection of the particles along a two-fold symmetry axis reveals orthogonal layers ... separated by long (L) and short (S) intervals arranged into a Fibonacci sequence.
c, Self-similar triangular patches related by the golden mean ... along a three-fold axis.
d–**g**, The particles are highly mobile, as confirmed by changes in the Penrose tiling. We show snapshots after 10 (**d**), 20 (**e**), 50 (**f**) and 100 (**g**) million simulation time steps. **a** and **f** show the same time step.
h, The particles are highly mobile, as confirmed by the van Hove autocorrelation function **G**a projected along a five-fold axis.
The observed phason flips allow the quasicrystal to equilibrate efficiently ...".

A University of Michigan news release said:
"... the particles only interacted with those up to three particle-distances away. ...".

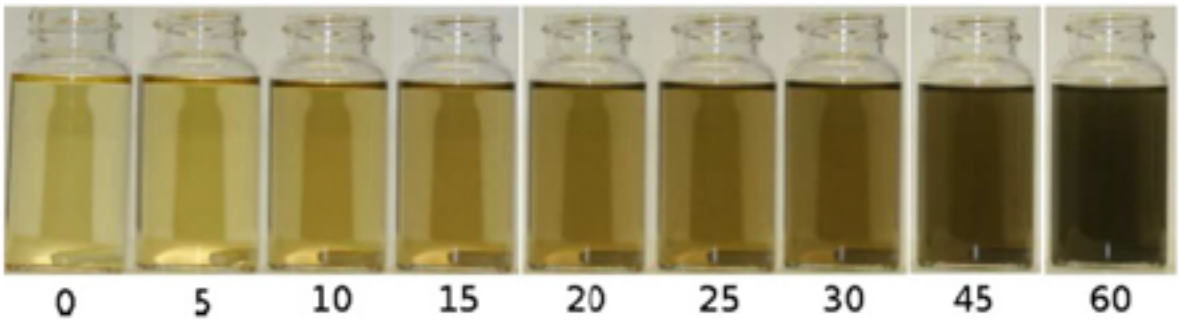
The 2, 3, and 5 fold diffraction symmetry axes corrrespond to the
Cube Face Projection, Cube Diagonal Projection, and Icosahedral Projection



of the 240 E8 Root Vectors of Cl(16)-E8 Physics
as described in viXra 1501.0078v3 and 1405.0030vG

What Physical System could be Icosahedral Colloidal QuasiCrystals ?

147-atom Pd clusters (diameter about 1.5 nm) in Methanol Colloidal Supsension
have been produced at Sandia National Laboratories and University of New Mexico Center for Micro-Engineered Materials, according to a Journal of Catalysis article
"Facile, surfactant-free synthesis of Pd nanoparticles for heterogeneous catalysts"
at http://www.flintbox.com/public/filedownload/2871/2011-038%20Science%20Direct%20Article
by Patrick D. Burton, Timothy J. Boyle, and Abhaya K. Datye.
Here is a recipe:
1 - 15 ml of methanol (MeOH) in a scintillation vial
2 - Add 5 mg palladium acetate (Pd(OAc)2) whose color is red-orange
3 - Reduce the Pd(OAc)2 by MeOH to Pd atoms
by stirring for 5 minutes with unobstructed exposure to room lighting.
4 - Place on elevated stir plate and allow to react undisturbed for 20 minutes
during which time the Pd atoms form clusters that grow to size 1.5 nm (147 atoms)
and color of colloidal suspension changes from pale yellow to dark

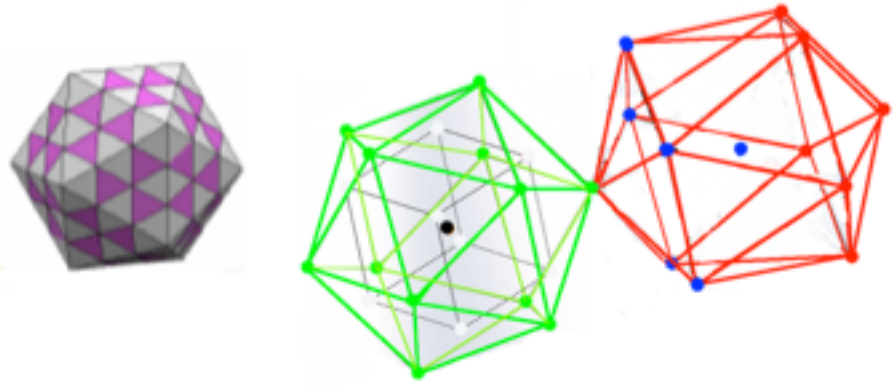


What Size Clusters of Palladium Colloid in Methanol have Icosahedral Structure ?

The 13-atom Pd cluster (0.70 nm) is an icosahedron shell around a central atom:

The 2-shell 55-atom Pd/Ni cluster (1.13 nm) is the next level of icosahedral structure. It contains two 13-atom icosahedra that share a central vertex:

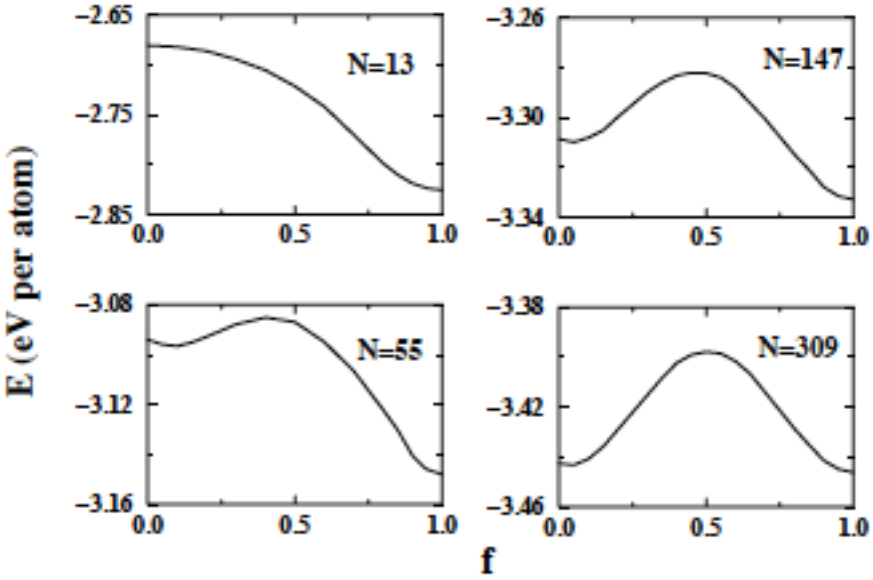
The 3-shell 147-atom Pd/Ni cluster (1.56 nm) is the next larger icosahedral structure. It contains 12 exterior 13-atom icosahedra plus 1 central 13-atom icosahedron whose 12 outer vertices are shared, each with one vertex of the 12 exterior icosahedra:



The 4-shell icosahedral structure contains 309 atoms (2.00 nm).

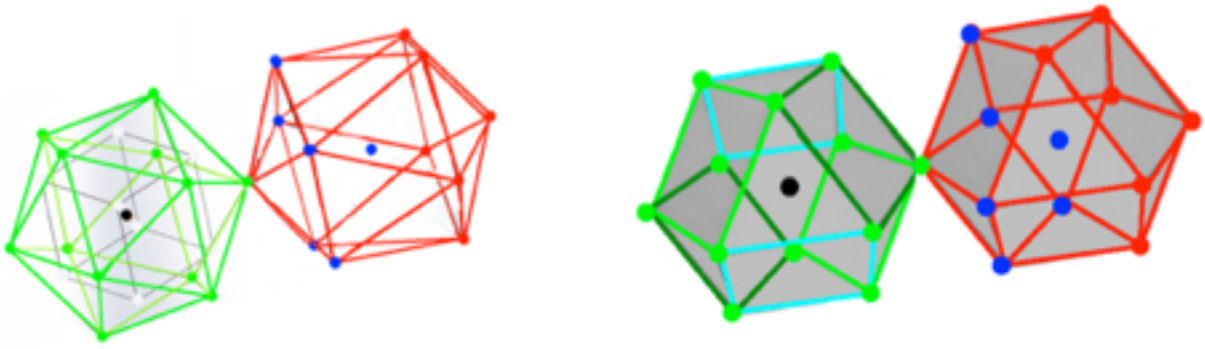
What Size Icosahedral Palladium Cluster is Most Stable ?

Barretau, Desjonqueres, and Spanjaard in Eur. Phys. J. D. 11 (2000) 395-402 say:
"... the icosahedron is the preferred structure at small sizes, and
the critical size at which the relative stability becomes favorable
to cuboctahedrons is N = 561 for PdN clusters ...[for which]...
For N = 13 the cuboctahedron is ... unstable.
For N = 55, 147, and 309 atoms the cuboctahedron is metastable and slightly distorted
...[Here is]... The evolution of the potential energy profile of homogeneously relaxed ...
PdN clusters during the Mackay [Jitterbug] transformation for increasing values of N ...



... f is a fraction of the displacements ...
f = 0 and 1 correspond to the ... cuboctahedron and icosahedron, respectively ...".

The most stable (lowest Energy per Atom) **Icosahedral Pd cluster is 147-atom**.
Note that the smallest Icosahedral Pd cluster (13-atom) has no metastable cuboctahedral state.
Since the 147-atom Pd cluster has a metastable cuboctahedral state
it can undergo the Jitterbug transformation that is necessary



for Pd-D Jitterbug TSC Schwinger Quantum Fusion (viXra 1502.0248 and 1501.0234v2) .

Can 147-atom Pd Clusters Colloid in Methanol be used for D Fusion ?

To avoid Hydrogen contamination of the TSC Pd-D Fusion process,
Deuterated Methanol MeOD = CD3OD should be used.
(Deuterated Methanol is widely used in NMR spectroscopy.)

Methanol reduces Palladium Acetate to Palladium, Methyl Acetate, and D and O.

$$2\ MeOD + Pd(OAc)2 = Pd + 2\ MeOAc + D2 + O2$$

The Methyl Acetate may precipitate out and settle to the bottom of the container so that,
by pouring off the top part, substantially pure Pd Cluster Colloid in Methanol is obtained.

A problem with storing the Pd Cluster Colloid in Methanol is that over time
the Pd Clusters may plate out onto the sides of the container.

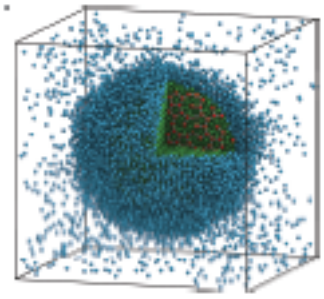
The O2 produced by reduction may react with the ambient solvent MeOD

$$2\ CD3OD + 3\ O2 \rightarrow 2\ CO2 + 4\ D2O$$

to produce Carbon Dioxide + Heavy Water.

Producing the 147 Pd atoms in a 147-cluster also produces 147 molecules of D2 gas,
some of which may react with some of the 147 molecules of O2 to form D2O
but enough may be absorbed into the Pd cluster (maximally 13x4 = 52 D atoms)
for an initial round of TSC Pd-D Fusion to take place.

If the Pd Cluster Colloid in Methanol is reloaded with D2 gas from an external source,
then Jitterbug reloading and repeating TSC Pd-D Fusion could take place throughout
an entire Icosahedral Colloidal QuasiCrystal containing about 20,000 Pd Clusters which
have mass 20,000 x 147 x 106 x 1.66 x 10^(-21) = 5 x 10^(-13) milligrams



which might maximally produce for each cycle of TSC Jitterbug Pd-D Fusion
20,000 x 13 x 47.6 MeV = 1.24 x 10^7 MeV = 5.5 x 10^(-13) kWh
or
by scaling up from 20,000 Pd Clusters as in computer simulation
to a physically more realistic 1 milligram = 4 x 10^16 Pd Clusters
(compare Avogadro number = 6 x 10^23)

about 1 KiloWatt-Hour per cycle per Milligram of Pd.

The Fusion Energy would be transferred by Hagelstein Relativistic Coupling between
Nuclear Fusion Excitation and Palladium Structure Vibrations from TSC Fusion sites
to Palladium Structure Excited Optical Phonon Modes
(see viXra 1502.0248v3)
and
then to Heating of the Ambient Methanol Solvent
from which
the Heat can be extracted by a Conventional Heat Exchanger.