

Bond Themes: 70s neutrinos & dense matter => 80s of dark matter => CMB & LSS & astrophysics => experimental CMB+ teamwork - the joys of the end-to-end pipeline

Entanglement *I love the collective*

the Movable Feast *the Universe as Party*

Have Transport will Travel *i love the technical & the deep: my career more or less*

Mother Nature still veils her secrets, *sigh No back of the book yet*

odds are **She does play the Cosmic Dice: cosmo-statistician** *Entropic vision*

Entanglement *quantum people science via friendship - collective phenomena*

all those honored here but also Efstathiou, Szalay, Carr, ... Kaiser, Frenk, White, ..

the Movable Feast - *then - and now key role of conferences,*

Aspen 82, IAU82, Moriond 83,

ITP 84 (*CDM resonance but also strings DEFW, DT/T, Gaussian stats, ..*), **InnerSpace/**

OuterSpace FNAL 84,

Aspen/Hawaii 86 (flows), Delta T over Tea 87, ...

& places: Caltech 70s Fowler++, Berkeley 78-81+ the great gathering, Cambridge 80s

Rees intuitions, Princeton 70s80s PJEP bibles, Stanford 81+, CITA 80s+ the Nick&Dick show; Chicago+Fermilab 80s+ the Mike&Rocky show, DaveSchramm & many more

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my response to George Efstathiou's "depression" at our Planck data just confirming at much higher precision the Standard Λ CDM Model of Cosmology - now with EE TE as well as TT

neutrinos, *why not since we know they are there.*

lost opportunity since we know at least \sim mass in stars

right-handed or sterile neutrinos

gravitinos, *great name for the DM.*

photinos *good name too, lightest supersymmetric partner & Rparity*

axions, *in nuclear physics from Fowler in 70s & stellar cooling. fascinating low mass CDM.*

now fuzzy DM (Kaiser-Widrow 90s@CITA, now industrial) BoseEinsteinC writ large

magnetic monopoles, beautiful ISM-Bfield relation, now magnetic dipoles Thompson@CITA FRBs

VeryMassiveBlackHoles as DM *we would have long been awash in GW*

favourite name = BoseBalls (80s@Stanford) light axion-ish bound by the self-potential

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Have Transport will Travel

Transport, Many Body / Collective idea pre-grad school + particle physics thus astroP**hysics
Entropy, Neutrinos and Supernovae @ Caltech**

=> VMBHs & astrophysics of reionization & binary BH GW

**=> massive neutrinos, oscillations from Fowler in 70s +.. 1980 Russian+Los Alamos expts,
SeeSaw Mechanism for nu mass. a key result: 1980 BES**

DT/T lower by order of magnitude+ Oort supercluster enthusiasm in Leiden very large structures

**=> 1981+ collisionless damping => hot, warm, cold & gravitinos, RH nus, axions, generic
the adiabatic CDM MIRACLE - turned adiabatic damping of the East into isocurvature shape
needed for galaxy clustering + z_gal of the West **Mother Nature did like this & still does****

$$k_{Heq}^{-1} = 5 \Gamma_{eq}^{-1} h^{-1} \text{ Mpc}, \quad \Gamma_{eq} = \Omega_{nr} h [\Omega_{er} / (1.68 \Omega_{\gamma})]^{-1/2}$$

universal scale, Δ matter density (Lambda, etc.), Δ relativistic particle content. other k-scales damping, h/m, ..

***Dark Matter as Black Holes - hedging the bets with Carr and Arnett
I learned Astrophysics of reionization and gravity waves from binary black holes and ..***

1981 In 'The Most Massive Stars', 315-337. ESO Properties and Cosmological Significance of Very Massive Objects, W.D. Arnett, J.R. Bond and B.J. Carr

1982 NATO ASI 90, 303-311, Supernovae: A Survey of Current Research, The Boundary Between VMO Collapse and Explosion, J.R. Bond, W.D. Arnett and B.J. Carr

1982 NATO ASI 90, 313-318, Supernovae: A Survey of Current Research, Pregalactic VMO's and Their Cosmological Consequences, B.J. Carr, W.D. Arnett and J.R. Bond

1984 Ap. J. 279, 825-847. The Evolution and Fate of Very Massive Objects, J.R. Bond, W.D. Arnett and B.J. Carr

1984 Ap. J. 277, 445-469. Cosmological Consequences of Population III Stars, B.J. Carr, J.R. Bond and W.D. Arnett

1984 MNRAS 207, 585-609 Gravitational Waves from a Population of Binary Black Holes, J.R. Bond and B.J. Carr

Mother Nature has delivered LIGO BH+BH->BH, DM to be sure, but low abundance

but as most DM, unattractive: non-adiabatic initial conditions & not nearly scale invariant
- so BHDM may be a CDM but no beauty of the adiabatic CDM MIRACLE here

Bond sample entanglements on the dark matter path

1980 DrNu meets the ever-young (now a mere ~62) leather-jacketed Durhamite, George Efstathiou, neutrinos get mass and i had a companion on my learning journey

Hungarian 70s rock star shows up at a 1981 Berkeley Xmas party fresh from Russian neutrino-entanglement with the Zeldovich school. Early 70s thesis work with Marx on massive nus. Alex & I damp & shock. Alex celebrates aging with new rock career.



Simon White AS & I do 1D Nbody neutrinos, i learn alot about phase-space wrapping but galaxies from HDM is baroque. Lynden Bell statistics. Tremaine and Gunn, didnt know about it at Caltech. brilliant.

1982 Alex connects us to Mike Turner => the collisionless damping on the gravitino gambit and warm DM. Cambridge dilemma: 82 - next big things, photon transport $\Delta T/T$ as damping followon, Gaussian random field 3D structure. GeorgeE wanted to join me in CMB & did!! BE84 => grand unified $\Delta T/T$ of BE87 CDM+BBE87 all LSS variations, LCDM, xCDM. in Cambridge AlexS joined on GRF LSS BBKS & shocking hydro.

@Cambridge the Nick & Dick show begins, 1982, infamous Crete/Paris trips with George too. random fields and bias. So Kaiser on BBKS86. ITP84 asked Bardeen to join BBKS => great intellectual pleasure => peak-patch/cosmic web 90s, and so on