**P-V Equations of state**

The 3rd order Birch-Murnaghan Equation of state:



Using the Eulerian strain:



The Birch-Murnaghan EOS to 4th order can be written as:



where



and



Vinet Equation of State



where  and 

Each student should go through the exercise of deriving the Birch-Murnaghan equation (to at least 3rd order) and the corresponding expression for the bulk modulus from a series expansion of the strain energy. For guidance, see:

FD Stacey et al., Finite Strain Theories and Comparisons with Seismological Data, Geophysical Surveys, 4, pp.189-232, 1981.

JP Poirier, Introduction to the Physics of the Earth’s Interior, Chapter 4, section 3

**Review Articles**

Title: Equations of state   
Author(s): Angel RJ   
Source: HIGH-TEMPERATURE AND HIGH-PRESSURE CRYSTAL CHEMISTRY  Book Series: REVIEWS IN MINERALOGY & GEOCHEMISTRY   Volume: 41   Pages: 35-59   Published: 2000

**This article gives a useful description of weighting and uncertainty analysis in EOS fitting. Do’t just use programs blindly, but strive to understand how they work!**

Title: Pressure-volume-temperature equations of state   
Author(s): Duffy TS, Wang YB  
Source: ULTRAHIGH-PRESSURE MINERALOGY - PHYSICS AND CHEMISTRY OF THE EARTH'S DEEP INTERIOR  Book Series: REVIEWS IN MINERALOGY   Volume: 37   Pages: 425-457   Published: 1998

**Parameter Trade-offs in Equation of state fitting**

Title: ELASTIC PROPERTIES FROM ACOUSTIC AND VOLUME COMPRESSION EXPERIMENTS   
Author(s): BASS JD, LIEBERMANN RC, WEIDNER DJ, et al.  
Source: PHYSICS OF THE EARTH AND PLANETARY INTERIORS   Volume: 25   Issue: 2   Pages: 140-158   Published: 1981

**F-f Analysis technique**

Title: FINITE STRAIN ISOTHERM AND VELOCITIES FOR SINGLE-CRYSTAL AND POLYCRYSTALLINE NACL AT HIGH-PRESSURES AND 300-DEGREE-K   
Author(s): BIRCH F   
Source: JOURNAL OF GEOPHYSICAL RESEARCH   Volume: 83   Issue: NB3   Pages: 1257-1268   Published: 1978

Title: FINITE-STRAIN EQUATION OF STATE FOR HIGH-PRESSURE PHASES   
Author(s): JEANLOZ R   
Source: GEOPHYSICAL RESEARCH LETTERS   Volume: 8   Issue: 12   Pages: 1219-1222   Published: 1981

**Finite Strain Inversion of Seismic Data**

Title: Elasticity, composition and temperature of the Earth's lower mantle: a reappraisal   
Author(s): Jackson I   
Source: GEOPHYSICAL JOURNAL INTERNATIONAL   Volume: 134   Issue: 1   Pages: 291-311   Published: JUL 1998

Jackson, I., Composition and temperature of the Earth’s mantle: Seismological models interpreted through experimental studies of Earth materials, in The Earth’s Mantle: Composition, Structure, and Evolution, I. Jackson, ed., pp. 405-460, 1998.

Jeanloz, R. and E. Knittle, Reduction of Mantle and Core Properties to a Standard State by Adiabatic Decompression”, in Chemistry and Physics of Terrestrial Planets, (Advances in Physical Geochemistry, volume 6) Edited by Surendra K. Saxena. Springer-Verlag Berlin Heidelberg New York, 1986., p.275-309

**Vinet Equation of State**

Title: A UNIVERSAL EQUATION OF STATE FOR SOLIDS   
Author(s): VINET P, FERRANTE J, SMITH JR, et al.  
Source: JOURNAL OF PHYSICS C-SOLID STATE PHYSICS   Volume: 19   Issue: 20   Pages: L467-L473   Published: JUL 20 1986

**Other Articles of Interest**

Title: Constraints on the P-V-T equation of state of MgSiO3 perovskite   
Author(s): Shim SH, Duffy TS   
Source: AMERICAN MINERALOGIST   Volume: 85   Issue: 2   Pages: 354-363   Published: FEB 2000

Title: High pressure equations of state and planetary interiors   
Author(s): Stacey FD   
Source: REPORTS ON PROGRESS IN PHYSICS   Volume: 68   Issue: 2   Pages: 341-383   Published: FEB 2005

**The Classics**

Title: FINITE ELASTIC STRAIN OF CUBIC CRYSTALS   
Author(s): BIRCH F   
Source: PHYSICAL REVIEW   Volume: 71   Issue: 11   Pages: 809-824   Published: 1947

Title: ELASTICITY AND CONSTITUTION OF THE EARTH INTERIOR   
Author(s): BIRCH F   
Source: JOURNAL OF GEOPHYSICAL RESEARCH   Volume: 57   Issue: 2   Pages: 227-286   Published: 1952