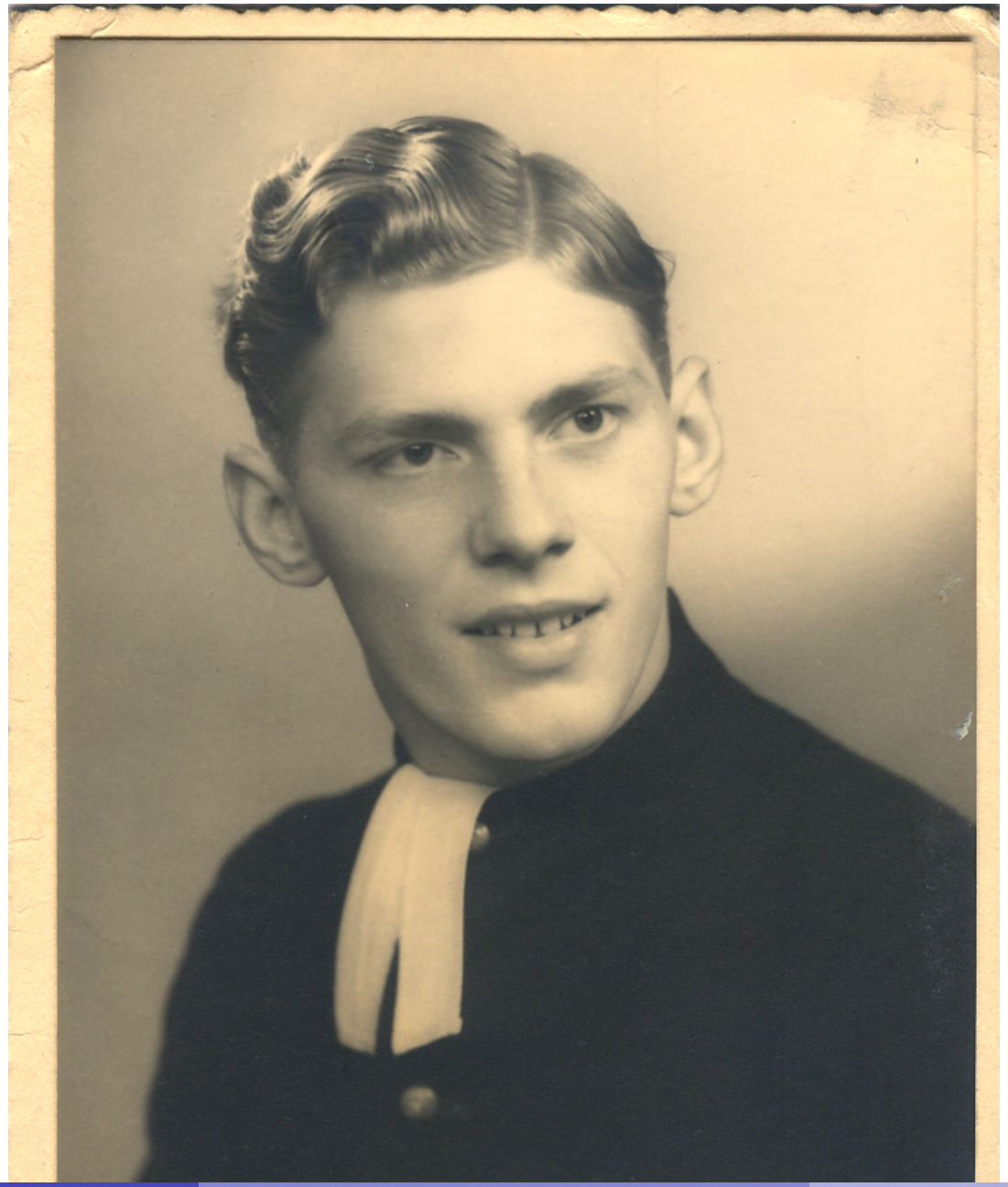
Michael Stephens: 1927-2019

Richard Lockhart

Nov 1, 2019

MAS at QEH



Why this talk?

- Michael had a big impact on this department:
  we should say thanks.
- Michael had a big impact on my career:
  I should say thanks.
- Michael did influential work in our discipline:
  you should have an idea what that work is.

Today's Subjects

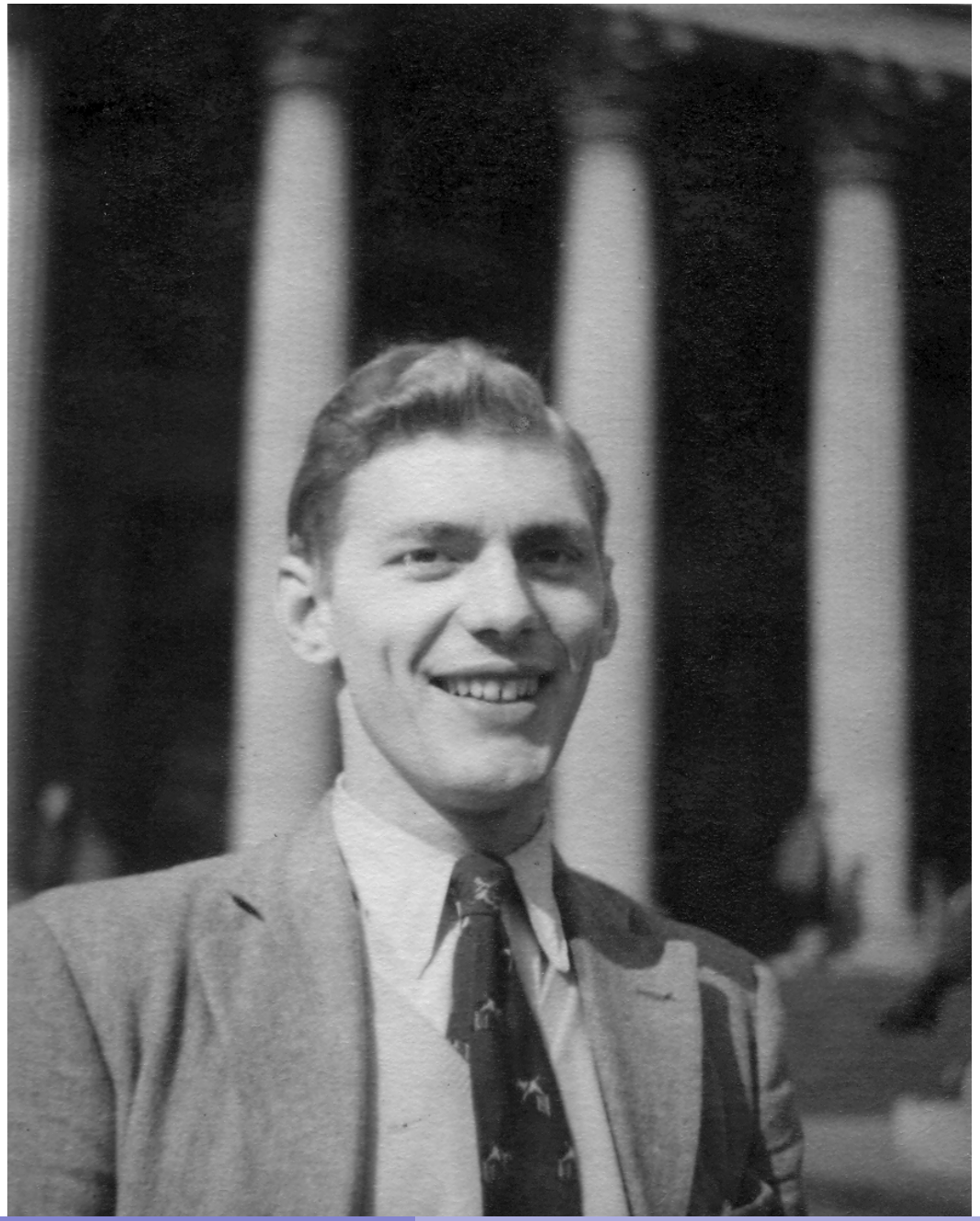
- Biography
- Directional data
- Goodness-of-fit
- The growth of our department.
- Impact on others.

Born in Bristol: April 26, 1927

Attended Queen Elizabeth's Hospital

Boys dressed Differently

Studied Physics at Bristol; BSc 1948

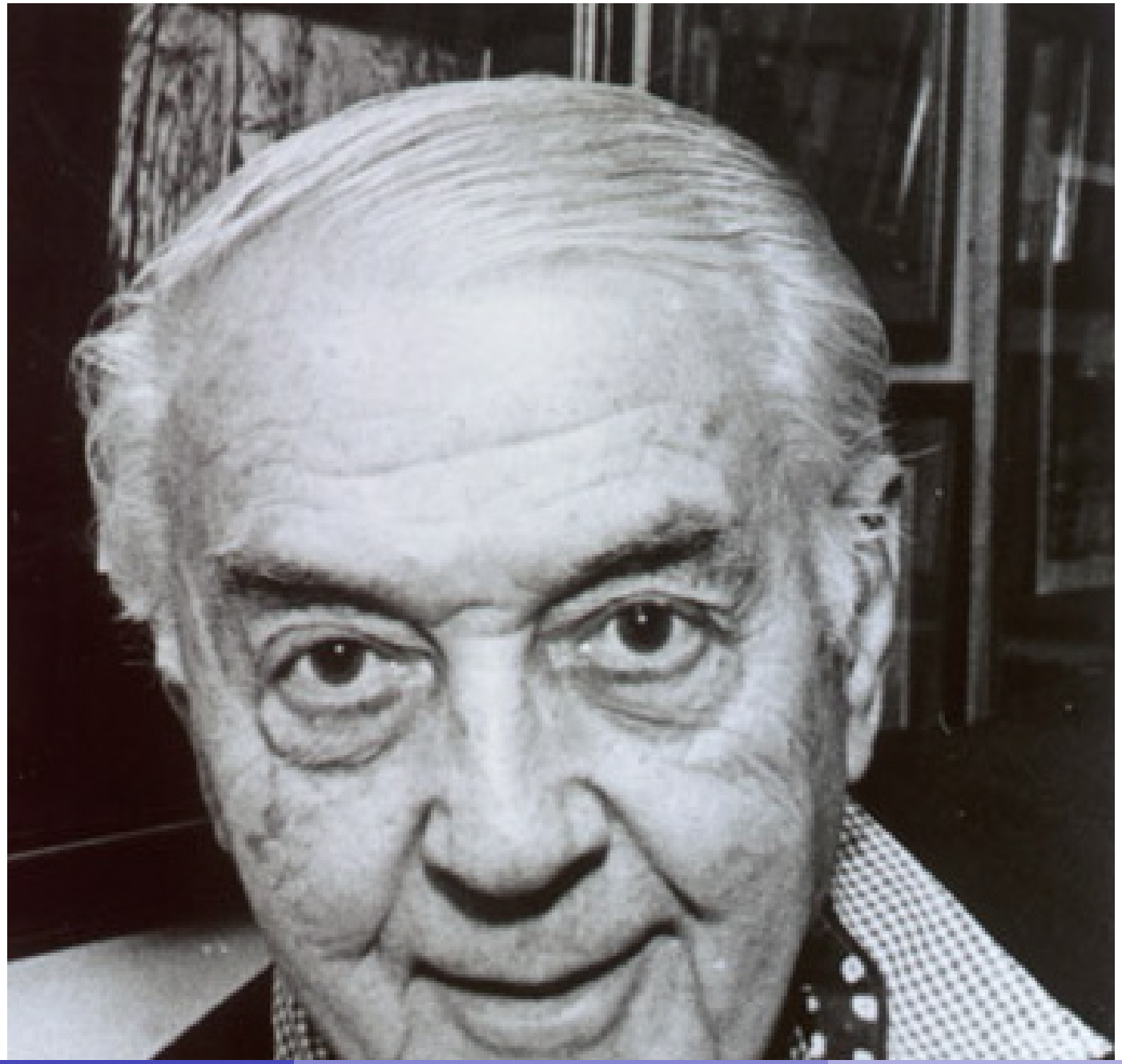


AM in Physics: Harvard 1949

Teaching

- Tufts
- Woolwich Polytechnic
- Battersea Polytechnic
- Case Institute of Technology (now Case Western Reserve)
- University of Toronto

PhD at U of T 1962 with Geoff Watson



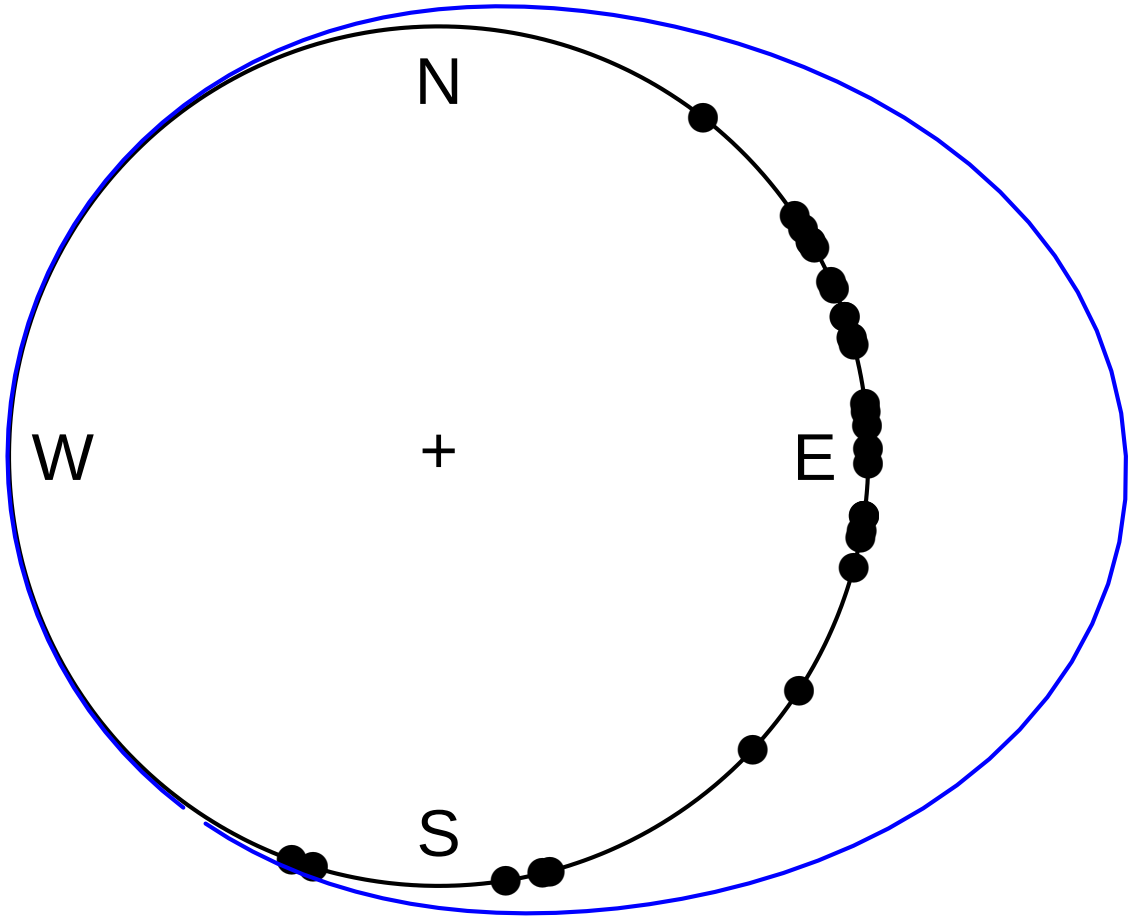
He married Evelyne in 1962

Evelyne was a couturière

Michael's Work

- *Biometrika* was an early favourite.
- Look at the contents in 1962-69!
- Directional data: distributions on the circle and sphere
- Goodness-of-fit: Watson's U^2
- Goodness-of-fit.

Periwinkles ($n = 31$) from Fisher and Lee (1972) 15



The von Mises Density

Density around circle added to the last plot:

$$f(\theta; \kappa, \theta_o) = \frac{\exp(\kappa \cos(\theta - \theta_o))}{2\pi I_0(\kappa)}$$

- Bessel function I_0 is the normalizing constant.
- This is a 2 parameter exponential family.

$$\mathbf{u} = (\cos\theta, \sin\theta)^\top \quad \boldsymbol{\tau} = (\cos\theta_0, \sin\theta_0)^\top$$

gives density on unit vector $\mathbf{u}$

$$f(\mathbf{u}, \boldsymbol{\tau}) = \frac{\exp(\boldsymbol{\tau}^\top \mathbf{u})}{2\pi I_0(\|\boldsymbol{\tau}\|)}.$$

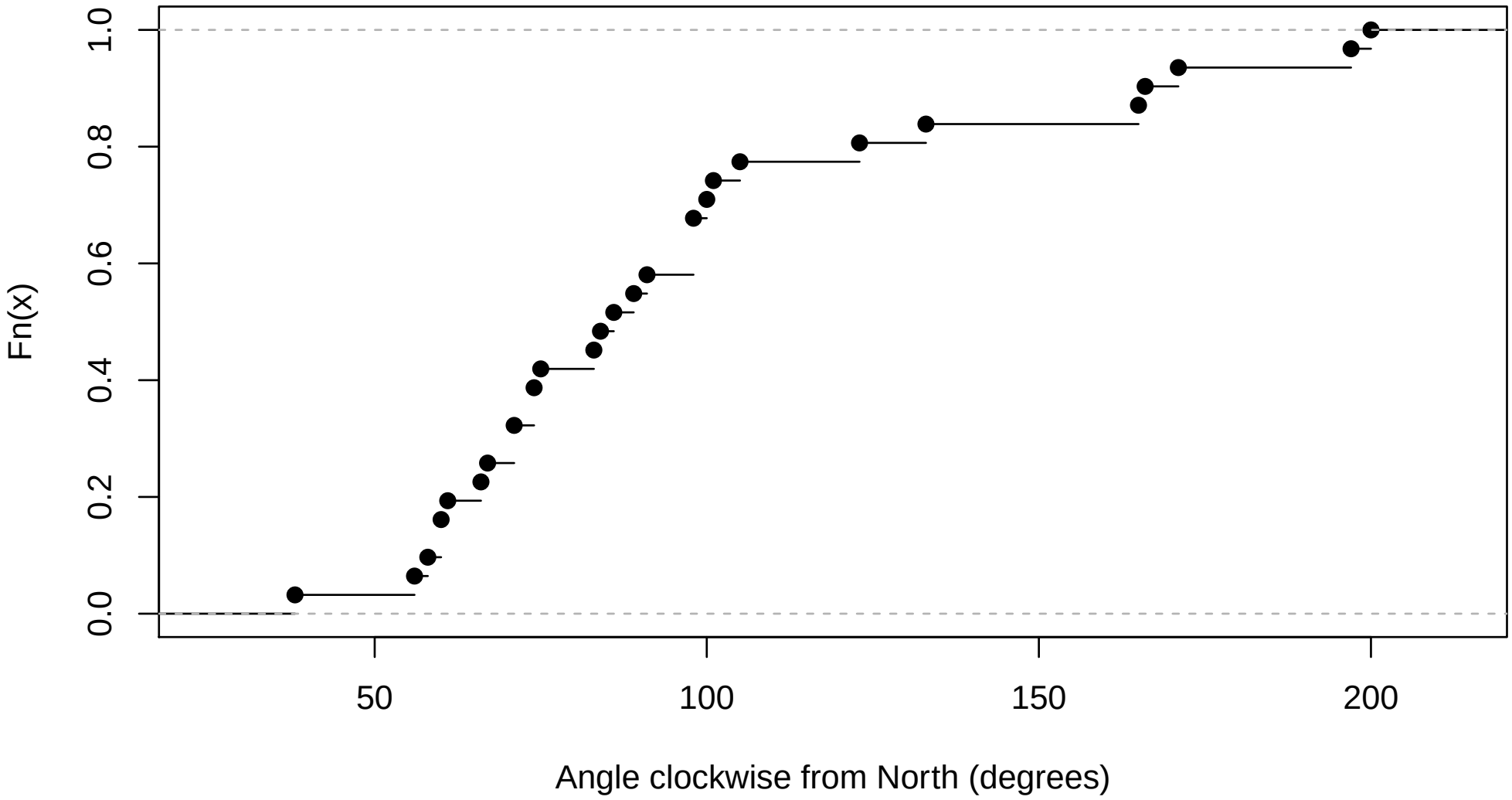
Some example topics: *Biometrika* titles

- *Exact and approximate tests for directions* I, II. Nomograms
- *Random walk on a circle*
- *Equatorial distributions on a sphere* (appendix to a Watson paper)
- *Tests for the dispersion and for the modal vector of a distribution on a sphere*
- *Multi-sample tests for the Fisher distribution for directions*.
- *Tests for the von Mises distribution*

Goodness-of-fit

- Many directional data papers concerned tests for 'randomness'
- Same as testing null hypothesis of uniformity on circle.
- This is goodness-of-fit: simple null hypothesis here.
- Watson's statistic U^2 is starting point.
- Modification for circle of Cramér-von Mises W^2.
- Led to lifelong study of Empirical Distribution Function (EDF) tests.

EDF for periwinkles



EDF tests

- The EDF is the random cdf F_n defined by

$$F_n(x) = \frac{1}{n}\sum_{i=1}^{n} \mathbb{I}(X_i \le x).$$

- Compared to $F(x, \hat{\theta})$ to test fit to model with param θ.
- Tests based on *Empirical Process*:

$$\hat{W}_n(x) \equiv \sqrt{n}\left\{F_n(x) - F(x;\hat{\theta})\right\}$$

- Measure 'size' by univariate summary.

$$\sup_x |\hat{W}_n(x)| \quad \text{Kolmogorov-Smirnov}$$

$$\int_x \hat{W}_n^2(x) dF(x, \hat{\theta}) \quad \text{Cramér-von Mises}$$

$$\int_x \frac{\hat{W}_n^2(x)}{F(x;\hat{\theta})\left\{1 - F(x;\hat{\theta})\right\}} dF(x, \hat{\theta}) \quad \text{Anderson-Darling}$$

Key ideas in Michael's work

- EDF tests more powerful than most.
- Much more powerful than tests based on densities.
- Assessing fit globally rather than locally is more powerful.
- Estimating θ *matters*. (cf. Shapiro-Wilk test)

Global not local

- Null $F = F_0$ is same as $f = f_0$.
- But *framing* of question suggests approach.
- Mean squared error of F_n on order $1/n$.
- MSE of $\hat{f}$ bigger: $1/n^{4/5}$ at best.
- Makes density tests *typically* less powerful than EDF tests.

Parameter estimation effects: large samples

- Typical test statistic starts from

$$\frac{\text{Non-par Est} - \text{Est depending on } \hat{\theta}}{\text{Estimated Standard Error}}$$

- Estimator in denominator has low impact (none asymptotically)
- Estimator in subtraction changes variability of numerator.
- Sometimes a lot.
- Estimated empirical process much less variable.

Jobs: after finishing his PhD

- Toronto
- McGill
- Nottingham
- Grenoble
- McMaster
- SFU since 1976.

Gold Medalist: Statistical Society of Canada

Departmental History

- Early statisticians: Villegas, Eaves.
- MAS arrives 1976.
- Hires Weldon 1978, Lockhart 1979, Routledge 1980.
- That was a lot in those days!
- Forces of evil ("the Riekhoffs and the Bordens" and Applied Math) regroup.
- Swartz hired 1986 as Villegas retires.
- Then Dean, Schwarz, Sitter in quick succession.
- Michael is FLORA (Forcibly Laid Off at Retirement Age) in 1992.
- By now the group is very healthy: some great hires for my money.

Personal History

- Michael visited me in Berkeley in Fall 1978 ish.
- I gave a set theory chalk talk here; MAS pushed for me anyway.
- By 1982 or 1983 it was clear I was struggling.
- Michael asked me to help with GOF for von Mises.
- Critical change of life for me.
- He didn't need my help, though.
- We have 15 papers together.
- But many more of mine required MAS to exist.

Stuff I didn't talk about

- His relationship with Egon Pearson.
- His interests in politics, theatre, night clubs.
- His role as an after dinner speaker.
- His unbelievable memory for people's lives.
- His ability to brush my excuses aside.
- His interest in students.
- His role in the SSC.
- The tidiness, or lack therof, of his desk, office, house.
- ...

Links and thanks

Michael's cv is available on-line.
A conversation with Michael which provides more detail on his early life is here.
More pictures next.

Neyman-Pearson statistics

A Nomogram: $\nu o \mu o \sigma$ (nomos≈law)

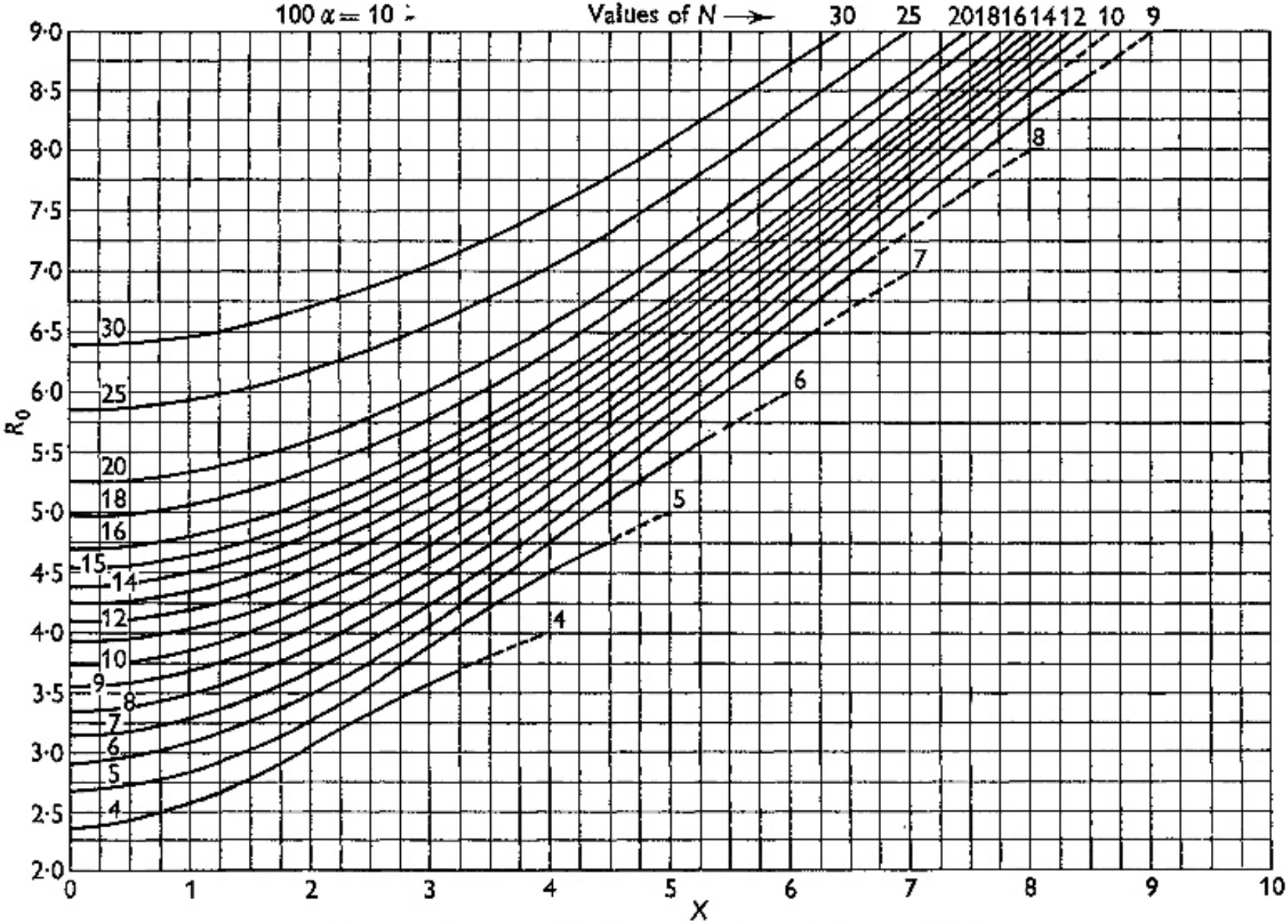
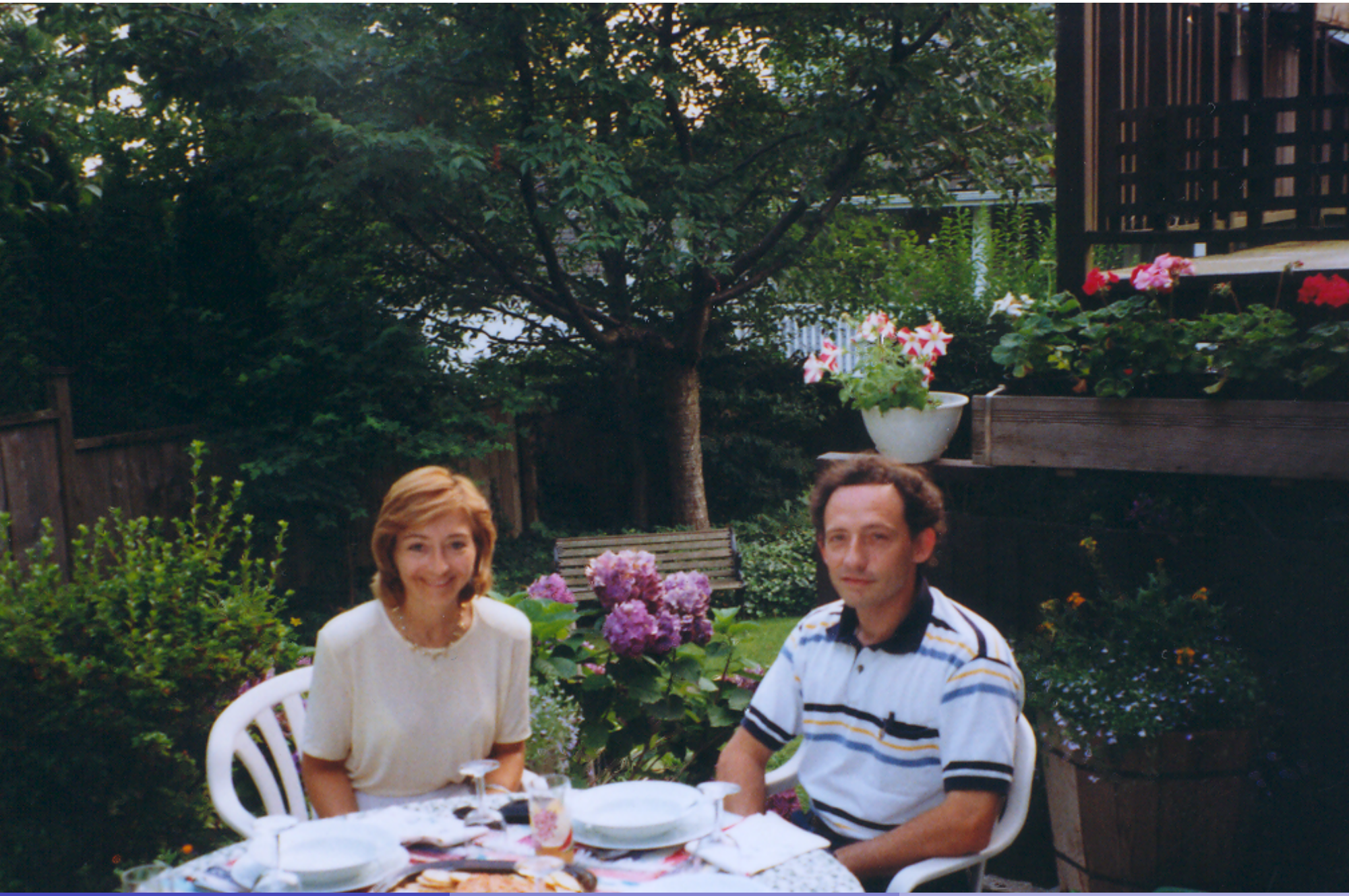


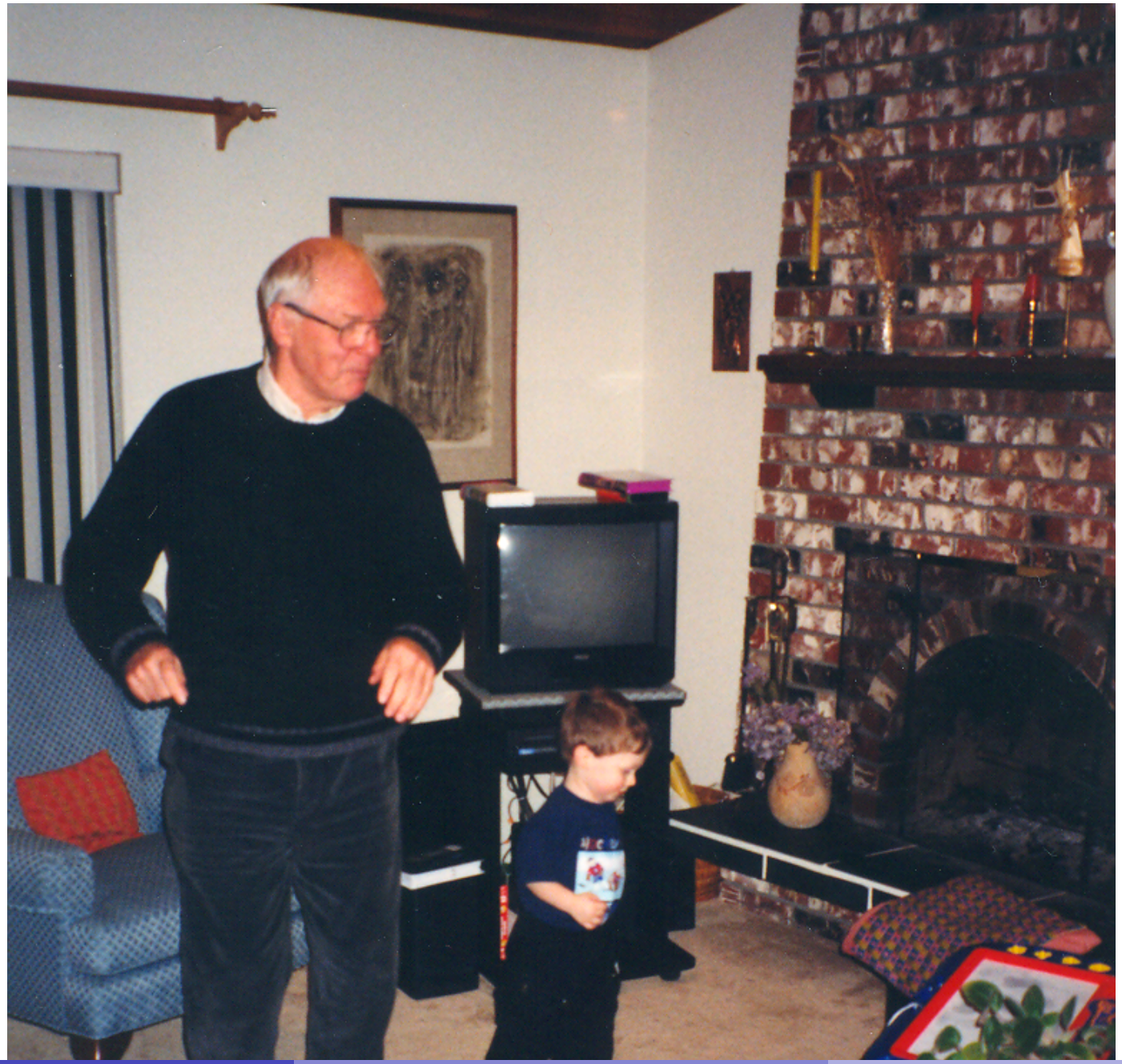
Fig. 1. Values of R_0 for given N and X, $\alpha = 0{\cdot}10$.

Pedro



China, 1984

Alexander



Convocation

Ted and Dorothy Anderson

Giovanni Silva and Gerry Chalk

Guanajuato

Rugby: Bristol second

Family 2015

Bates, O'Reilly, Stephens, Kim